MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. LXI. DECEMBER 14, 1900. No. 2

E. B. KNOBEL, Esq., PRESIDENT, in the Chair.

Sri Rajah Ankithum Venkata Jugga Row Bahadur, Yambram Estates, Vizagapatam, India ; and
Ernest H. Shackleton, Master Mariner, Aberdeen House, West Hill, Sydenham, S.E.,

were balloted for and duly elected Fellows of the Society.

The following Candidates were proposed for election as Fellows of the Society, the names of the proposers from personal knowledge being appended :—

The Rev. George Gaskell-Vickars, Grange-over-Sands, North Lancashire (proposed by Washington Teasdale) ; and
Otto Hilger, Scientific Instrument Maker, 204 Stanhope Street, Hampstead Road, N.W. (proposed by Maures Horner).

Mr. H. Seward, Dr. D. Smart, and Mr. R. Inwards were appointed auditors of the Treasurer's accounts for the year 1900.

Seventy-six presents were announced as having been received since the last meeting, including, amongst others :—

Rev. J. M. Bacon, By Land and Sky, presented by the Publishers ; Cordoba Observatory, Durchmusterung Catalogue, Part 3, presented by the Observatory ; Warner & Swasey, A few Astronomical Instruments, presented by Messrs. Warner & Swasey ; L. Weinek, Photographischer Mond-Atlas, Heft 10, presented by Dr. Weinek.

The Diameter of the Asteroid Juno (3), *determined with the Micrometer of the* 40-*inch Refractor of the Yerkes Observatory, with remarks on some of the other Asteroids.* By E. E. Barnard.

During 1894 and 1895 I secured measures of the diameters of the four largest asteroids, *Ceres* (1), *Pallas* (2), *Juno* (3), and *Vesta* (4), with the 36-inch of the Lick Observatory (see *Monthly Notices* for December 1895, vol. lvi. p. 55).

At that time *Juno* was at the limit of measurement, and it was a question whether the diameter then obtained was the true one or whether it was simply the spurious disc, for measurements of stars of about the same magnitude as *Juno* gave results almost the same as those obtained for *Juno*.

On account of the large eccentricity of the orbit of this asteroid some oppositions are much more favourable than others. The opposition of 1894 (during which the diameter was measured) was not a favourable one.

It was hoped that in its nearer oppositions measures might be obtained which would leave no doubt of the size of the planet.

The opposition of 1896 was favourable, but the 40-inch was not yet ready for observations, and I have not heard of any measures being obtained elsewhere.

The present opposition of 1900 was a favourable one. A close watch was kept on the planet for opportunities to secure measures. It was looked at a number of times, but there were only five dates on which the disc could be seen for measurement. The diameter was carefully measured at these times, and the results are believed to be good. They verify in a satisfactory manner the measures of 1894.

In the present measures a magnifying power of 1340 diameters was used, and several times one of 1700 was also used.

When best seen, the disc was clear cut and round, with no discernible markings. The planet is yellowish in colour.

Diameter of Juno (3).

1900.	Observed.	At Δ 2·7673.
	″	″
Sept. 13	0·26	0·11
19	0·23	0·10
29	0·23	0·10
Oct. 8	0·22	0·09
11	0·20	0·08
		0·096

At distance unity this becomes 0″·266, which corresponds to a diameter of 120 miles.

The mean value is derived from results carried out to three decimal places.

The values 0″·095 and 0″·263 from the measures of 1894 are as closely in agreement with the above results as can be expected; this is specially pleasing after having waited six years for a chance to measure the planet again.

In *Monthly Notices* for 1900 January, vol. lx. p. 261, I have given some measures of *Ceres* (1) and *Vesta* (4), obtained with the 40-inch, which, though not made under as favourable conditions as the measures of 1894 and 1895, are in close agreement with those measures.

I will collect here, for convenience of reference, the results of all my measures of these four asteroids, combining the measures of *Ceres* and *Vesta* made with the 40-inch with those obtained with the 36-inch, but retaining only the measures of *Juno* made with the 40 inch, because of the unfavourable position of the planet in 1894.

These measures are, I believe, as fair a representation of the true diameters of these small bodies as it is possible for one observer to obtain. I have faith in their goodness.

	Δ 2·7673.	Δ 1.	In Miles.	
	″	″		
Ceres (1)	0·383	1·060	477	28 nights.
Pallas (2)	0·244	0·675	304	5 ,,
Juno (3)	0·096	0·266	120	5 ,,
Vesta (4)	0·192	0·531	239	21 ,,

For completeness I will repeat here from *Monthly Notices*, 1895 December, the values of the albedos which my measures, obtained in 1894 and 1895, give for these asteroids, assuming *Mars* = 1·00.

Albedos.

Ceres	0·67	Juno	1 67
Pallas	0·88	Vesta	2 77

Perhaps none of the other asteroids have diameters sufficiently large ever to come within the measuring power of our powerful telescopes. Their diameters therefore will have to be determined by the interference method which M. Maurice Hamy has shown, in the case of *Vesta*, gives identical results with those obtained with the micrometers of the great telescopes.

There is one other member, however, whose diameter will be readily determined under favourable conditions. *Eros* at its nearest approach should present a disc not far from a half-second in diameter, and this is an easily measurable quantity. This latter planet is of a yellowish colour in the great telescope.

In connection with these asteroid diameters I have also measured the diameters of all the planets and satellites measurable. These measures are collected in a paper in *Popular Astronomy* for 1897 October. The title of the paper is "A Micrometrical Determination of the Dimensions of the Planets and Satellites of the Solar System made with the 36-inch Refractor of the Lick Observatory."

On Observations of Capella as a Double Star made at the Royal Observatory, Greenwich. By W. H. M. Christie, M.A., F.R.S., Astronomer Royal.

The observations of *Capella* as a double star, initiated by Mr. Dyson and Mr. Lewis, have been continued at every favourable opportunity, and this rapid binary has now been followed through two and a half revolutions. The following observations have been made in continuation of those published in the *Monthly Notices* for June, vol. lx. p. 595.

Date (Astronomical) 1900.		Date from Jan. 1, 1900.	Observer.	Position-Angle.	Mean.	Hour-Angle.
d	h	d		°	°	h
July 10	$3\frac{1}{2}$	190·1	Mr. Bryant	293·9	294·2	$6\frac{3}{4}$ W.
	$3\frac{1}{2}$		Mr. Bowyer	294·6		$6\frac{3}{4}$ W.
11	$0\frac{1}{2}$	191·1	Mr. Bryant	289·6	300·5	$4\frac{1}{4}$ W.
	2		Mr. Lewis	311·5		$2\frac{1}{2}$ W.
12	$0\frac{1}{2}$		Mr. Lewis	288·2		$2\frac{3}{4}$ W.
	$0\frac{1}{2}$	192·0	Mr. Bowyer	280·0	286·6	$2\frac{3}{4}$ W.
	$1\frac{1}{4}$		Mr. Bryant	291·5		$3\frac{1}{2}$ W.
13	1		Mr. Bryant	288·4		3 W.
	$3\frac{3}{4}$	193·1	Mr. Bowyer	289·9	288·8	$5\frac{3}{4}$ W.
	4		Mr. Christie	288·1		6 W.
14	3	194·1	Mr. Bryant	284·1	284·1	$5\frac{1}{2}$ W.
15	16	195·7	Mr. Bowyer	272·7	272·7	$5\frac{1}{4}$ E.
16	$3\frac{1}{2}$	196·1	Mr. Bowyer	272·5	276·6	6 W.
	$3\frac{1}{2}$		Mr. Witchell	280·7		6 W.
18	$0\frac{1}{2}$		Mr. Bowyer	265 8		3 W.
	$0\frac{1}{2}$	198·0	Mr. Furner	261·9	266·9	3 W.
	2		Mr. Witchell	273·0		$4\frac{1}{2}$ W.
Aug. 13	$23\frac{1}{4}$		Mr. Furner	190·0		$3\frac{1}{2}$ W.
	$23\frac{1}{4}$	225·0	Mr. Bowyer	185·7	190·8	$3\frac{1}{2}$ W.
	$23\frac{1}{2}$		Mr. Bryant	196·6		$3\frac{3}{4}$ W.
15	$22\frac{1}{2}$	226·9	Mr. Bryant	189·2	189·2	3 W.
28	22	239·9	Mr. Bryant	142·0	142·0	$3\frac{1}{2}$ W.
Sept. 3	$22\frac{3}{4}$	246·0	Mr. Bryant	111·2	111·2	$4\frac{1}{2}$ W.
5	22		Mr. Bryant	102·4		$3\frac{3}{4}$ W.
	$22\frac{1}{4}$	247·9	Mr. Dyson	105·7	106·4	4 W.
	$22\frac{2}{4}$		Mr. Lewis	111·2		$4\frac{1}{2}$ W.
7	$21\frac{3}{4}$	249·9	Mr. Bryant	95·8	95·8	$3\frac{3}{4}$ W.
9	$23\frac{1}{2}$	252·0	Mr. Bryant	88·8	88·8	$5\frac{3}{4}$ W

Date (Astronomical) 1900. d	h	Date from Jan. 1, 1900. d	Observer.	Position-Angle. °	Mean. °	Hour-Ang. h
Sept. 10	$21\frac{1}{2}$	252·9	Mr. Bryant	84·9	89·8	$3\frac{3}{4}$ W.
	$21\frac{3}{4}$		Mr. Lewis	94·7		4 W.
11	23	254·0	Mr. Bryant	82·5	82·5	$5\frac{1}{4}$ W.
12	$21\frac{1}{2}$	254·9	Mr. Bryant	78·4	81·7	$3\frac{3}{4}$ W.
	$22\frac{1}{2}$		Mr. Lewis	84·9		$4\frac{3}{4}$ W.
14	$23\frac{3}{4}$	257·0	Mr. Bryant	73·2	73·2	$6\frac{1}{4}$ W.
16	22	258·9	Mr. Bryant	67·2	67·2	5 W.
18	$21\frac{1}{2}$	260·9	Mr. Bryant	56·6	56·6	$4\frac{1}{2}$ W.
19	$21\frac{1}{4}$	261·9	Mr. Bryant	55·1	58·7	$4\frac{1}{4}$ W.
	22		Mr. Christie	62·4		$5\frac{1}{4}$ W.
21	$23\frac{3}{4}$	264·0	Mr. Lewis	58·0	58·0	$6\frac{1}{4}$ W.
30	$20\frac{1}{4}$	272·8	Mr. Bryant	17·4	17·4	4 W.
Oct. 7	20	279·8	Mr. Bryant	349·6	349·6	6 W.
21	21	293·9	Mr. Bryant	290·2	290·2	6 W.
Nov. 7	$20\frac{1}{2}$	310·8	Mr. Bryant	239·5	239·5	$6\frac{1}{2}$ W.
9	22	312·9	Mr. Bryant	232·0	232·0	$5\frac{3}{4}$ W.
23	8	326·3	Mr. Lewis	193·5	193·5	$4\frac{1}{2}$ E.
27	$9\frac{1}{2}$	330·4	Mr. Bowyer	186·7	186·7	$3\frac{1}{4}$ E.
Dec. 7	8	340·3	Mr. Bryant	144·4	144·4	$4\frac{1}{4}$ E.
10	8	343·3	Mr. Lewis	(120 ±)		4 E.

It is to be noted that *Capella* cannot be observed within about $2\frac{1}{2}$ hours of the meridian (except by means of a diagonal reflector), the eye end of the telescope being too near the floor when the telescope is pointed to the neighbourhood of the zenith.

The observations have been grouped to obtain normal places, the observations in the second and third revolutions being made comparable with those in the first by subtracting 104 days and 208 days respectively from the dates of observation (expressed in days from the beginning of the year). The period has thus been provisionally assumed to be 104 days, as deduced by Mr. Newall from spectroscopic observations, though the observations hitherto published seem hardly sufficient to fix the period within a day. The visual observations so far obtained would be somewhat better satisfied with a period of about 103 days, but the data are necessarily uncertain, and further observations are required to determine whether the assumed period of 104 days may require to be slightly diminished. The observations from April 23 to May 11 have not been included in the groups, as the observers seem to have been to some extent influenced by colour effects which affected the measures, *Capella* having been observed at a large hour-angle in the evening sky. The mean position-angles for the groups and the mean daily motion for the intervals between

the groups are given in the following table, together with the corresponding quantities calculated for a provisional orbit, found by trial to approximately satisfy the observations so far obtained :—

Day from beginning of Year.	Observed Angle.	Computed Angle.	C−O.	Observed Mean Daily Motion.	Computed Mean Daily Motion.	Computed Radius Vector.
d	°	°	°	°	°	
87·7	290·7	292·7	+2·0	2·45	3·08	0·97
92·8	278·2	277·0	−1·2	2·41	2·82	1·01
105·9	246·6	240·0	−6·6	3·69	3·16	1·03
121·2	190·1	191·7	+1·6	3·55	3·71	0·91
134·8	141·8	141·3	−0·5	3·89	3·47	0·90
147·2	93·6	98·3	+4·7	3·32	3·25	0·95
156·5	62·7	68·1	+5·4	3·47	3·71	0·94
169·6	17·3	19·6	+2·3	4·47	4·18	0·85
175·8	349·6	353·7	+4·1	3·70	3·84	0·84

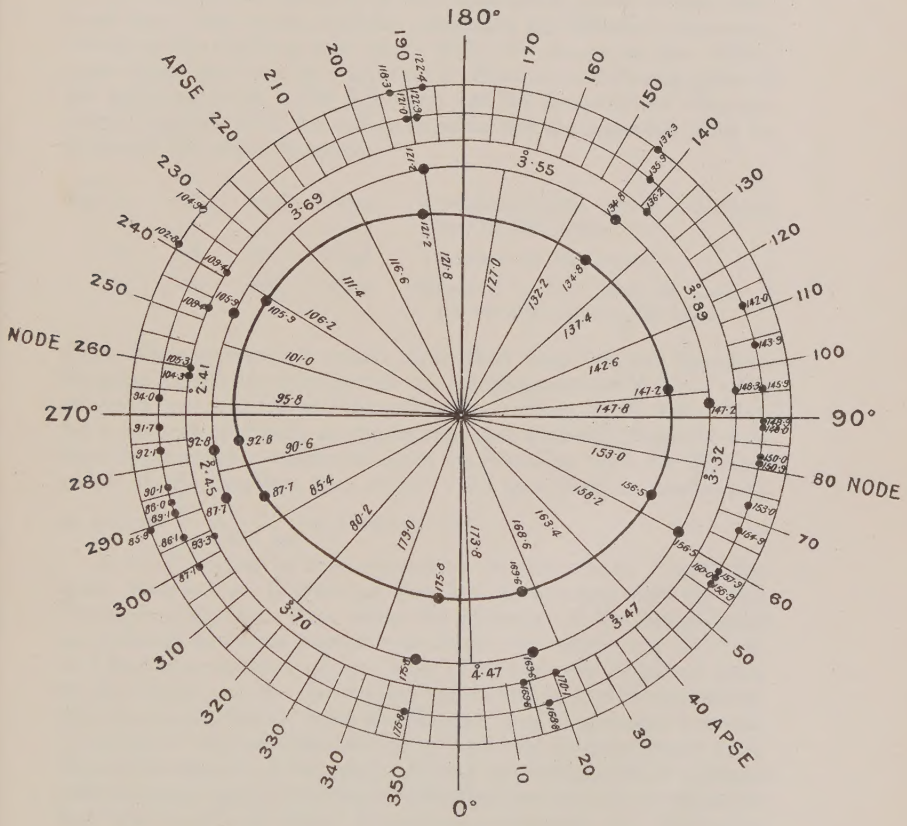
The values of the mean daily motion show that the apparent path is not far from circular, and a closer examination indicates that the plane of the orbit is inclined about 30° to 35°, the line of nodes being at about 80°, and that there is a very small eccentricity in the true orbit. This accords satisfactorily with Mr. Newall's spectroscopic observations, which, with a period of 104 days, give 1900 June 4, represented by 154^{d} in the table, as the epoch of maximum relative velocity, corresponding to position-angle 76° in the apparent orbit, which is quite close to the line of nodes at about 80° as indicated by the visual observations. For the provisional orbit used for the calculated position-angles and mean daily motions the following elements have been taken :—

Inclination, 30°. Position-angle of node, 80°.
Eccentricity, 0·05. Position-angle of periastron, 40°.

The values of C−O indicate that this orbit represents the observations so far available within the limits of error for such a difficult double star, but further observations and an alteration in the assumed period of revolution would doubtless materially modify these elements, especially the eccentricity and periastron. The comparison with this provisional orbit, however, suffices to indicate that the visual observations accord satisfactorily with the spectroscopic observations as regards the period of revolution, the date of passing through the node (corresponding approximately to date of maximum velocity of the solar component) and small eccentricity.

The diagram exhibits the results of the two tables graphically, the position-angles observed during the three revolutions being indicated on the three circles with the corresponding dates,

Position Angles of Capella observed as a Double Star at the Royal Observatory, Greenwich, 1900, with the deduced Apparent Ellipse.



The observations of position angle are indicated on three circles by the day of the year, 104 days and 208 days respectively being subtracted in the second and third revolutions to make them comparable with the first.

The means of groups are indicated on the innermost circle, and the corresponding computed positions on the apparent ellipse.

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expressed in days reckoned from 1900 January $1^h{\cdot}0$ G.M.T. (astronomical), 104 days being subtracted for the second revolution, and 208 days for the third. On the innermost circle the mean observed position-angles for groups are indicated with the dates, and within this the apparent ellipse (provisional) with the position-angles corresponding to the mean dates of groups. The position-angles for every 18° of mean anomaly (representing 5·2 days) are also shown for convenience. The observed mean daily motion for the intervals between groups is also shown round the innermost circle.

As regards the distance of the components, three actual measures have been made, besides estimates by different observers, which on the whole accord fairly with the measures, due allowance being made for the variation in distance at different parts of the apparent orbit. The following are the measures of distance made, together with the radii computed for the apparent orbit in terms of the mean distance :—

1900	d	"		
Sept. 6	248	0·09	0·94*a*	6 measures by Mr. Bryant, micrometer read by Mr. Lewis.
20	158	0·06	0·93*a*	2 measures by Mr. Bryant.
22	160	0·06	0·92*a*	Measures by Mr. Lewis, in terms of the breadth of the spider lines.*

From these measures it would result that $a=0''{\cdot}08$, and therefore that the maximum distance of the components would be $0''{\cdot}083$, at about 100^d, and the minimum $0''{\cdot}066$, at about 170^d. This value for a accords as closely as can be expected with Mr. Newall's data from spectroscopic observations in combination with Dr. Elkin's value of the parallax, viz., $0''{\cdot}08$. In fact, with an inclination of 30°, $a=\frac{52}{93}\times\frac{1}{\sin 30^\circ}\times 0''{\cdot}08=0''{\cdot}09$.

It is of interest in this connection to note that κ *Pegasi* has been observed at Greenwich (by Mr. Lewis and also by Mr. Dyson in 1896 and 1897), when the distance of the components (as inferred from the angular velocities) was only $0''{\cdot}05$ or $0''{\cdot}06$, and that observations of 42 *Comæ* (Σ 1728) were obtained (also by Mr. Dyson and Mr. Lewis) just before and just after nearest approach or occultation, when the distance was in each case between $0''{\cdot}05$ and $0''{\cdot}04$, the distances being fixed with great accuracy from the circumstances of the orbit. It may be noted also that κ *Pegasi* (which is now again becoming a difficult object) was observed on the last four nights on which *Capella* was observed, viz. November

* There are two spider lines in the filar micrometer, and Mr. Lewis found that the thinner line, $0''{\cdot}08$ in breadth, covered the star disk completely in all positions except that corresponding to the direction of elongation 60°, while the thicker wire, $0''{\cdot}14$ in breadth covered it in that position. It results that the apparent star disk under the conditions of observation was less than $0''{\cdot}08$ in diameter for each component, and that the distance of the components was about $0''{\cdot}06$.

23, 27, December 7 and 10, and that the elongation in the case of *Capella* was noted as being quite as distinct as in the case of κ *Pegasi*, for which Mr. Lewis estimated the distance as under $0''.1$. On December 10 Mr. Lewis (though unable to get a satisfactory measure of position-angle owing to unsteadiness of the image shortly before the sky clouded over) satisfied himself of a distinct elongation in *Capella*, the definition being very fine momentarily, so that he was able to *count* eight rings round the star, using a magnifying power of 1120, there being at least ten or more complete rings visible.

The two components of *Capella* do not differ much in brightness, but there is a consensus of opinion amongst the observers that the position-angles as given indicate the direction of the fainter star. Mr. Bryant in particular has noted his impression as to this on several occasions, and I can confirm this on July 13, when the star appeared distinctly egg-shaped, with the smaller end in the position-angle given. On September 19 I had the impression that the fainter star was in the first quadrant, not the third, but the elongation was then smaller, and I do not feel so much confidence as to which end of the elongated image was the smaller.

In making the observations, neutral-tinted or deep-blue shades were used to reduce the brightness of the star. Many of the observations were made in the daytime, when the brightness was naturally much reduced.

Royal Observatory, Greenwich:
1900 *December* 14.

ζ *Herculis.* By T. Lewis.

R.A.	$16^h\ 37^m\ 31^s$	1900.	Mag. A.	3·0	Yellow.
N.P.D.	$58°\ 13'\ 1''$		Mag. B.	6·5	Bluish Green.

Sir William Herschel found this star to be double on 1782 July 18, and on July 21 he measured the position-angle as $69°.3$. In 1795 he noted that it was in the n.f. quadrant, and remarked that the distance was smaller than in 1782. In 1802 and 1803 he failed to separate the pair, but measured the angle on three occasions :—

1802·74	219°·2
1802·81	5°·7
1803·29	116°·8

Thus, while it was evident that the pair formed a binary system of short period, these observations left the matter in a very unsatisfactory state, which did not improve by the failure of Sir J.

Herschel and South to see the companion from 1821 to 1825. With regard to the failure in 1802 and 1803, Dr. See states that "at this time the position-angle was 174°·5 and distance 1″·24," and it therefore seems strange that Herschel could not make any satisfactory measures.

Since Herschel's time three revolutions of the companion have been completed, and yet there are certain circumstances connected with the system which require elucidation. For instance, Dr. See computed an orbit in 1895, and so recently as 1900 Dr. Doolittle, using observations down to 1897·6, made a careful investigation, and deduced what may be considered as the most satisfactory orbit. Yet, when the ephemerides are compared we see that they both fail, *e.g.* :—

	See.		Doolittle.		Observed.	
	°	″	°	″	°	″
1899·5	289·7	0·47	273·9	0·59	263	0·60
1900·5	258·4	·58	247·7	·77	240	0·78
1901·5	233·0	·80	230·6	·92		

It must, however, be understood that as periastron passage occurred in 1898, the ephemeris is here subject to large errors, due in great measure to the inequality of the components and their closeness. Still, the errors are too large.

The present paper is an attempt to set forth the peculiarities of motion in this system, and by an appeal to the Greenwich Transit Circle observations get some idea of the causes. For convenience the subject is dealt with in three distinct parts.

(1) Discussion of micrometric measures.

(2) Discussion of meridian observations and their combination with the micrometric measures.

(3) Discussion of circumstances arising from these, and remarks on magnitude, colour, and proper motion.

Part I.

Discussion of Micrometer Measures.

All the micrometric measures of this pair which could be found have been tabulated in the order of date and yearly means formed according to the following plan :—

The result of 1 night's measures	received	a	weight		1
,, 2 or 3 nights'	,,	,,	,,		2
,, 4, 5 or 6	,,	,,	,,		3
,, over 6	,,	,,	,,		4

The yearly means thus obtained differ but little from those obtained by adopting any other similar system of weighting. These means were then plotted and a line drawn through them in

such a manner as to make individual residuals as small as possible, no regard being paid to the number of inflexions. From these smoothed means the position-angles and distances at the commencement of each year were read off and tabulated. These positions were then laid down as in fig. 1, where N represents the true north point and A the principal component, which is assumed

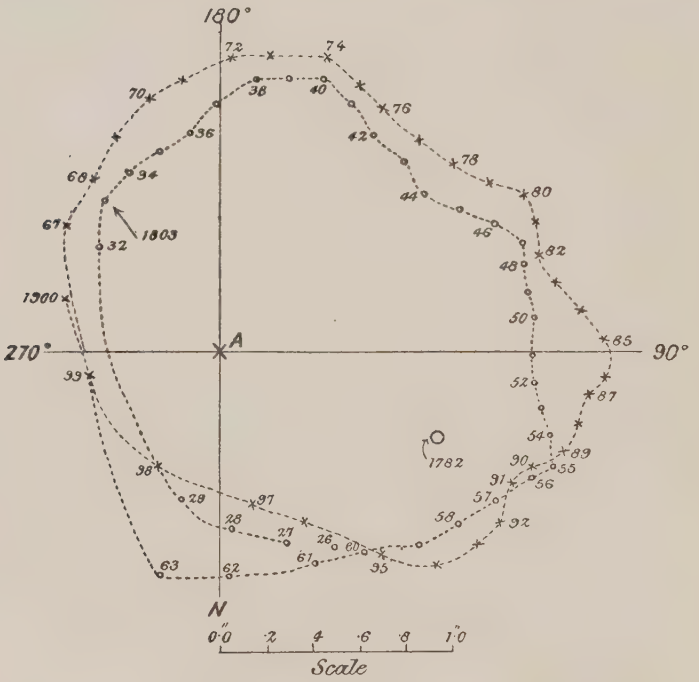


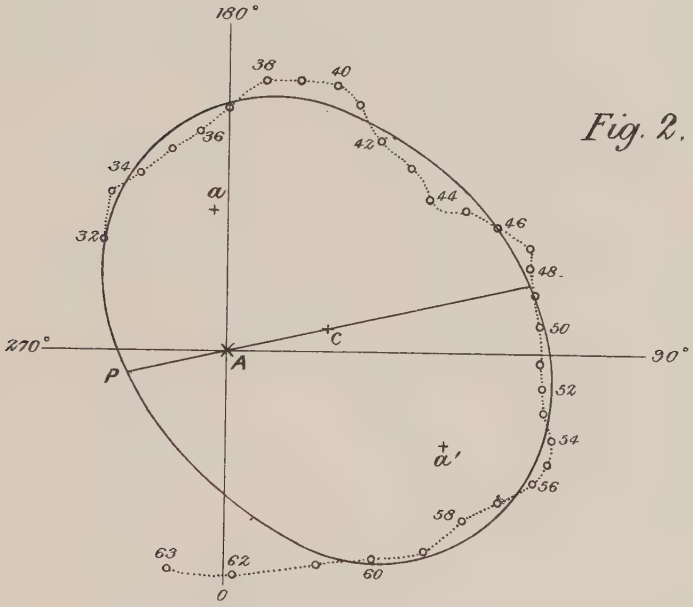
FIG. 1.—Positions from yearly means of angles and distances, A being the principal component and assumed fixed.

at rest. It is at once apparent that no single ellipse could satisfy these positions, for

(1) The series of positions 1832 to 1860 are inside those for the period 1867 to 1895.

(2) A radius vector from A passes through

1832	and	1867,	giving a period of	35 years
1837	,,	1871½	,, ,,	34½ ,,
1844	,,	1878	,, ,,	34 ,,
1851	,,	1885½	,, ,,	34½ ,,
1859	,,	1893	,, ,,	35 ,,


180°
270°
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C
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a'
32
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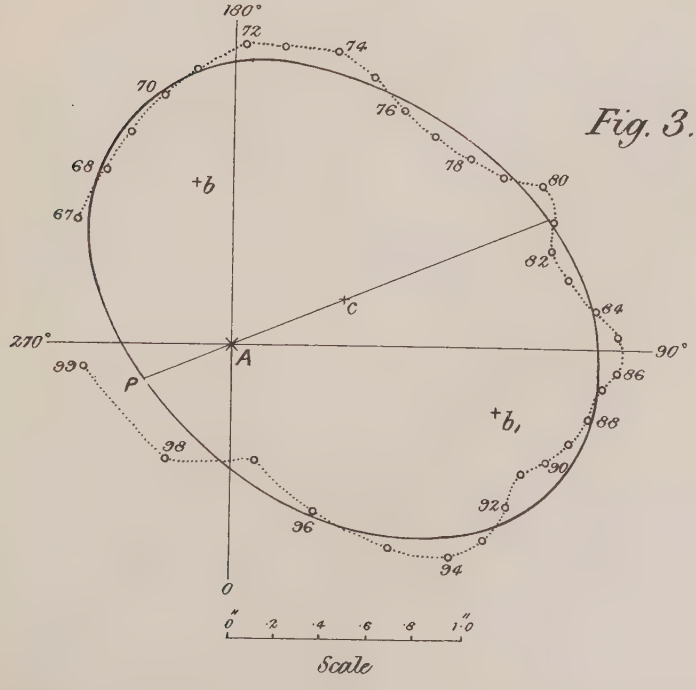
63

Fig. 2.


180°
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84
86
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90
92
94
96
98
0″ ·2 ·4 ·6 ·8 1″·0
Scale

Fig. 3.

Consequently, each period has been treated separately and quite independently. Thus, in fig. 2 (Plate 2) the positions from 1832 to 1863 are laid down and an ellipse drawn which appears to best satisfy the measures. Similarly, fig. 3 (Plate 2) shows the positions from 1867 to 1899 with the ellipse best representing them.

These ellipses represent the apparent orbits, the elements of which are

	Fig. 2.	Fig. 3.
Length of major axis	2″·19	2″·40
Length of minor axis	1·67	1·75
Angle of major axis	224°·6	232°·5
Angle of periastron	283·6	293·8
Distance of star A from centre	0″·45	0″·52

and the corresponding elements of the true orbits :

τ	Periastron	1864·03	1898·09
P	Period in years	32·4	33·9
a	Semi-major axis	1″·25	1″·40
e	Eccentricity	·504	·560
☊	Node	35° 29′	40° 59′
γ	Inclination	46 42	50 18
λ	Angle in true ellipse between node and periastron	254 36	258 48

It will be noticed that in fig. 1 observations are laid down for the years 1782, 1803, 1826 and 1829. I have made no use of these, the meagre material leaving too much room for individual prejudice. It so happens, however, that Maedler computed two orbits—one in 1842 and another in 1847—in which these measures necessarily have great weight, at least, this is so in the 1842 orbit. We may hence adopt Maedler's orbit for the period anterior to the two now given, provided we bear in mind the slender material from which it is deduced.

The three periods then give, in chronological order :

	τ	P	a	e	Ω	γ	λ
(1)	1829·50	31·46	1″·19	·455	39°	51°	262°
(2)	1864·03	32·4	1·25	·504	35	47	255
(3)	1898·09	33·9	1·40	·560	41	50	259

in which the chief points noticeable are

1. The increase in P, a, e.

2. The discrepancy between the period obtained from considerations of motion in each ellipse by itself and that deduced from one periastron passage to another.

3. The apparent constancy of the line of nodes and of the inclination.

The discrepancy in (2) is still more remarkable when we take into account the motion of Periastron, from which a decrease in the time from one periastron passage to the next might be expected. The discussion of the varying period led, amongst other things, to the interesting curve in fig. 4 (Plate 3). This curve results from the following process:—Using the smooth curve already obtained from the observed position-angles, the angles at the commencement of each year beginning at 1832 were tabulated, and the time noted when such angle recurred. Thus the angle for 1832·0 is 229°·0, and it occurs again in 1867·1, or 35·1 years later. A whole series of such time-intervals being obtained and laid down with the initial years as abscissæ.

To make this portion complete the computed orbits are appended.

P	τ	e	a	Ω	γ	λ	Authority.	Date
			″	°	°	°		
31·47	1829·50	0·455	1·19	39·4	50·9	262·1	Maedler	1842
30·22	1830·42	·432	1·21	19·4	44·1	276·7	,,	1847
36·36	1830·48	·448	...	214·4	43·7	284·9	Villarceau	...
37·21	1830·56	·438	...	37·2	39·4	266·9	Fletcher	1853
36·71	1830·24	·483	1·35	41·9	49·1	290·6	Villarceau	1854
34·22	1830·01	·424	1·22	45·9	34·9	209·5	Dunér	1871
36·61	1829·64	·551	1·37	27·0	50·2	266·7	Plummer	1871
34·58	1864·90	·405	1·36	26·1	51·1	261·0	Flammarion	1874
34·4	1864·8	·463	1·28	41·7	43·2	252·8	Doberck	1880
34·41	1864·78	·467	1·35	44·1	44·5	251·8	,,	1881
35·0	1864·80	·497	1·43	37·5	51·8	258·3	See	1895
34·53	1863·89	·457	1·36	54·1	47·8	247·4	Doberck	1899
34·55	1864·46	·456	1·38	48·7	45·0	249·6	Doolittle	1900

Micrometric Measures. Yearly Means.

The following Table is a summary of the yearly means of micrometer measures, weights being given according to the number of nights, as follows:

1 night	= weight	1
2, 3 nights	,,	2
4, 5, 6 ,,	,,	3
over 6 ,,	,,	4

also giving a weight of 1 to Smyth.

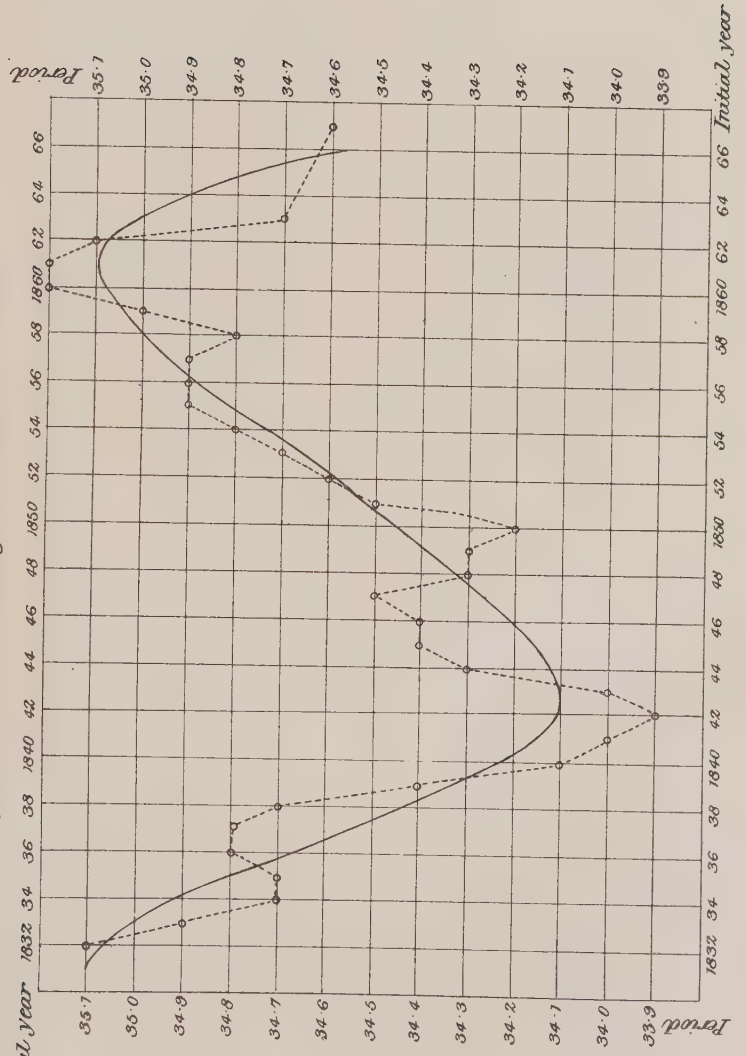


Fig. 4. Curve showing variation of Period

Date.	Angle.	Dist.	w
	°	"	
1782·55	69·3	< 1·0	1
1802·74	219	...	1
26·63	23·4	0·91	3
28·73	352·6	0·65	1
32·75	220·5	0·81	1
34·45	203·5	0·90	2
35·51	195·2	0·94	4
36·64	183·7	1·00	4
37·47	175·5	1·10	3
38·62	168·6	1·19	5
39·73	161·3	1·20	5
40·65	156·0	1·28	6
41·57	147·0	1·21	7
42·60	141·0	1·08	11
43·65	130·1	1·06	6
44·50	122·7	1·12	4
45·52	119·3	1·26	4
46·76	110·2	1·36	4
47·51	107·6	1·36	12
48·55	102·2	1·33	7
49·65	97·5	1·56	3
50·54	91·4	1·36	6
51·61	86·9	1·36	15
52·64	82·6	1·38	10
53·45	78·2	1·42	18
54·47	74·4	1·48	11
55·62	69·6	1·48	9
56·48	63·7	1·38	12
57·59	57·8	1·32	17
58·56	49·0	1·17	12
59·65	39·6	1·15	15
60·69	30·0	0·97	4
61·57	11·2	0·95	4
62·64	350·3	1·02	4
1863·49	343·1	...	3
1866·70	232·1	0·81	12
67·57	224·2	0·93	9
68·56	207·2	1·02	12
69·64	200·0	1·08	9
70·54	192·0	1·16	8
71·52	182·5	1·19	12
72·54	174·3	1·24	10
73·55	164·7	1·35	11
74·58	155·4	1·27	9
75·57	148·5	1·30	12
76·53	140·3	1·28	16
77·57	132·7	1·28	10
78·54	126·5	1·36	14
79·56	119·3	1·48	8
80·52	113·9	1·34	11
81·53	109·5	1·49	16
82·54	103·0	1·48	15
83·60	99·3	1·49	15
84·59	93·0	1·67	14
85·58	90·0	1·69	9
86·60	86·6	1·48	9
87·60	81·4	1·56	7
88·58	75·7	1·68	8
89·56	72·9	1·50	13
90·54	68·8	1·37	9
91·56	62·5	1·38	14
92·60	56·0	1·41	8
93·74	47·6	1·34	5
94·70	40·7	1·14	20
95·38	37·1	1·01	3
96·53	10·2	0·59	3
97·51	1·2	0·66	6
98·58	297·0	0·54	6
99·30	267·2	0·57	6
1900·60	239·0	0·79	3

Position at Commencement of each Year as read from the Curves.

Date.	Angle.	Dist.	Date.	Angle.	Dist.
	°	"		°	"
1826·0	30·0	1·00	1860	36·5	1·07
27	20·0	0·88	61	24·0	1·00
28	5·0	0·78	62	1·0	0·98
29	348·0	0·72	63	346·0	1·00
30	...	...	64	...	...
31	...	...	65	...	...
32	229·0	0·73	66	...	...
33	217·5	0·83	67	230·0	0·87
34	207·5	0·88	68	215·5	0·96
35	197·5	0·93	69	204·0	1·04
36	188·5	0·97	70	195·0	1·11
37	180·5	1·04	71	187·0	1·18
38	173·0	1·15	72	178·5	1·25
39	166·0	1·21	73	170·5	1·29
40	159·5	1·22	74	160·5	1·32
41	153·0	1·20	75	152·5	1·29
42	145·5	1·14	76	145·0	1·27
43	137·5	1·09	77	137·0	1·27
44	128·0	1·11	78	130·0	1·31
45	121·0	1·18	79	123·5	1·40
46	115·0	1·30	80	117·5	1·49
47	109·5	1·37	81	112·0	1·50
48	105·0	1·34	82	107·0	1·49
49	100·0	1·35	83	101·5	1·48
50	95·5	1·37	84	96·5	1·57
51	90·0	1·36	85	92·0	1·65
52	85·5	1·37	86	88·0	1·64
53	80·5	1·43	87	83·5	1·58
54	76·0	1·45	88	79·0	1·57
55	71·5	1·48	89	75·0	1·53
56	67·0	1·45	90	71·0	1·44
57	62·0	1·36	91	66·5	1·38
58	54·0	1·27	92	60·0	1·39
59	45·5	1·18	93	53·0	1·39
60	36·5	1·07	94	46·0	1·29
61	24·0	1·00	95	38·5	1·09
62	1·0	0·98	96	27·5	0·86
1863	346·0	1·00	97	11·0	0·65
			98	328·0	0·56
			99	280·0	0·56
			1900	252·0	0·65

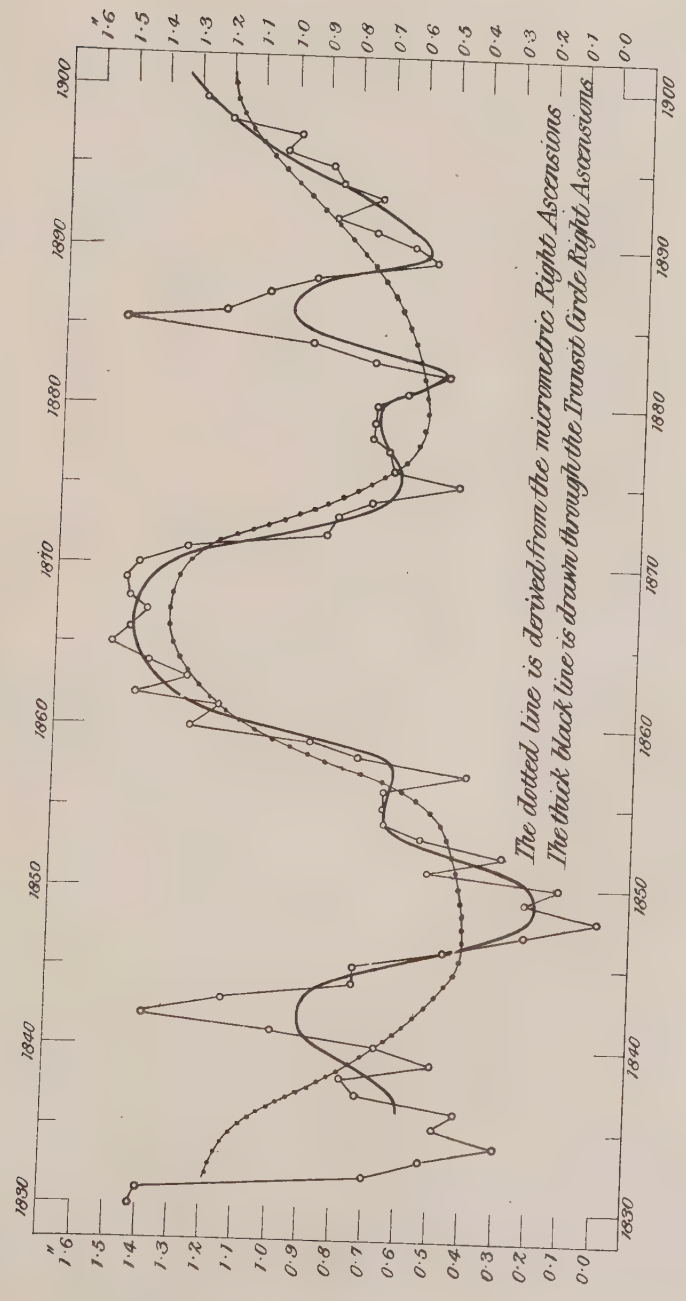

The dotted line is derived from the micrometric Right Ascensions
The thick black line is drawn through the Transit Circle Right Ascensions
1830
1840
1850
1860
1870
1880
1890
1900
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6

Fig. 5.

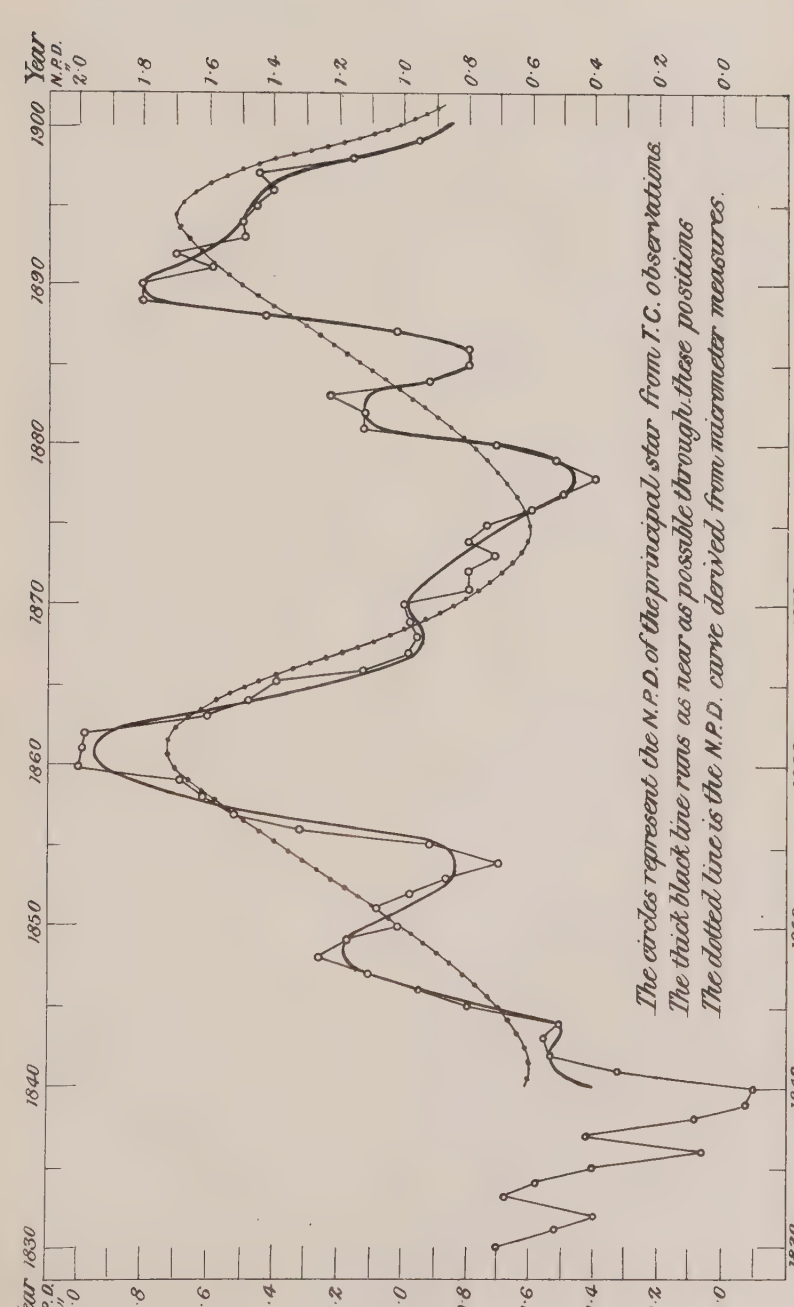

Year
N.P.D.
2·0
1·8
1·6
1·4
1·2
1·0
0·8
0·6
0·4
0·2
0·0
1830
1840
1850
1860
1870
1880
1890
1900
The circles represent the N.P.D. of the principal star from T.C. observations.
The thick black line runs as near as possible through these positions.
The dotted line is the N.P.D. curve derived from micrometer measures.

Fig. 6.

Part II.

Discussion of Meridian Observations, and their Combination with the Micrometer Measures.

Having found the micrometric measures so interesting, the observations of the principal star, made on the meridian at Greenwich, were then collected. These were found so meagre before 1850 that in the initial stage they were not used. Starting, then, at 1850 the Greenwich Right Ascensions and North Polar Distances were tabulated and reduced to 1900. It was at once seen that every possible observation previous to 1850 was desirable. Consequently observations were collected from all sources (before 1850) and reduced to 1900. Although not made use of, they have been tacked on the ends of the Greenwich series, and it must be understood that agreement or non-agreement with that series must not be taken too seriously. For convenience the Right Ascensions and N.P.D.'s are kept separate and treated independently of each other.

In reducing the R.A.'s a proper motion of $-0^{s}\cdot0375$ has been used, and originally the yearly results were used direct, as were also the N.P.D.'s, but finally it was decided to smooth them by taking the means of every three. Considering the nature of the observations, this appears quite legitimate, and results in having a less complicated series of dots to deal with.

These smoothed means are shown in fig. 5 (Plate 4).

The N.P.D.'s have been reduced with a proper motion of $+0''\cdot385$, the yearly means smoothed and laid down in fig. 6 (Plate 5).

The periodic nature of the curves both of R.A. and N.P.D. is evident, and similar to that deduced from the micrometric measures; consequently the positions and distances were converted into R.A. and N.P.D. The amplitude, however, seemed just about twice that of the transit Right Ascensions. At a venture the curve was then reduced one-half, and after reversion was fitted on to the transit Right Ascensions, and is shown by the continuous line in fig. 5, where it might well be mistaken for the curve really drawn through them.

Similarly, the N.P.D. curve deduced from the micrometric means was reduced one-half and fitted on the transit circle N.P.D.'s, as shown in fig. 6 (Plate 5).

In both cases the two sets of measures agree in a remarkable manner.

Hence it may be conceded that the real motion of the system is shown in fig. 7, where the left-hand ellipse is the apparent orbit of the principal star and the right-hand ellipse that of the fainter component.

The elements of the transit circle ellipse are :

☊	42° 32′	$e = \cdot500$.
γ	47 18	$a = 0''\cdot686$.
λ	76 50	P = 34 years (assumed).

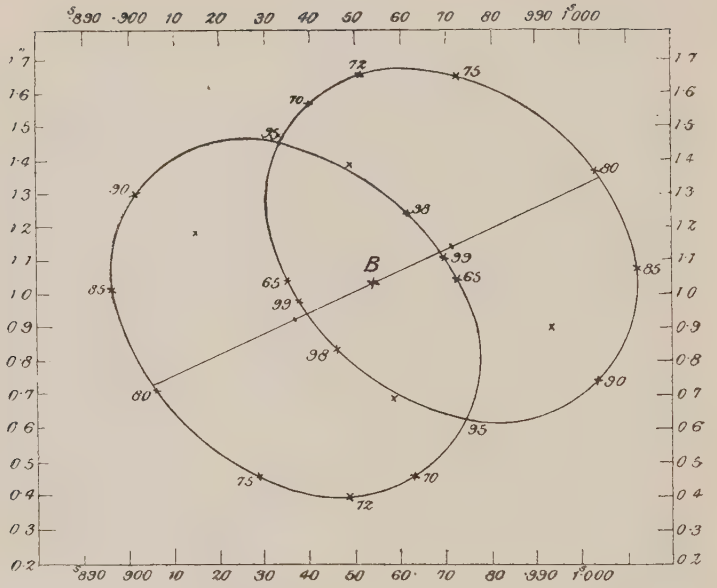


FIG. 7.—The left-hand ellipse represents the transit-circle observations from 1867 to 1869 as shown by the curves 6 and 7.
The right-hand ellipse is deduced from the first by laying off, from the several positions in that ellipse, the position-angles and distances derived from micrometric measures.

Meridian Observations collected from all Sources, reduced to 1900.

Year.	R.A. m	s	Seconds, 1900. s	Source.	N.P.D. °	′	Seconds, 1900. ″	Source.
1825	34	41·468	30·877	Σ	4	29″39	58·32	Σ.
26		43·735	·886	Σ	.	.	.	.
27		46·093	·987	Σ, Abœ		42·87	7·98	Σ, Abœ.
28		48·33	·966	G.		50·06	8·27	G.
29		50·553	30·932	Σ, Cam., G.	4	56·40	7·71	Σ, G.
30		52·919	31·039	Σ, G.	5	4·62	9·05	Σ.
31		55·08	30·941	Madras		8·74	6·26	Madras.
32		57·305	·907	Madras, G.		16·55	7·18	Munich.
33	34	59·510	·855	Munich		24·21	7·75	Σ, Munich, G., Madras
34	35	1·840	·927	G.		31·10	7·96	G.
35		4·030	·860	Munich		36·70	6·68	Munich.
36		...	...			...	...	
37		8·620	·933	R.		51·30	7·54	R.
38		10·860	·915	R.	5	58·50	7·88	R.

Year.	R.A. m	s	Seconds, 1900. s	Source.	N.P.D. ′	″	Seconds, 1900. ″	Source.
1839	35	13·110	30·908	R., Munich	6	4·72	7·23	R., Cam., G.
40		15·310	·850	R.		10·22	5·88	R.
41		17·690	·973	R.		19·09	7·88	R.
42		19·935	·959	R., Cam.		25·86	7·79	R., Cam., Poulkova.
43		22·200	·966	R.		32·35	7·42	R., Cam.
44						39·00	7·02	Cam.
45		26·682	·888	Madras, G.		46·78	8·17	Madras, Poulkova.
46		28·938	·913	R., G.	6	53·55	8·12	R., Cam., Poulkova.
47		...	...			...	...	
48		33·367	·839	G.	7	7·50	8·45	Brussels, G.
1849		35·627	30·842	G.	7	14·07	58·14	Brussels.

Σ = W. Struve, R. = Rumker, G. = Greenwich, Cam. = Cambridge.

Greenwich Transit Circle Observations.

Year.	R.A. m	s	No. of Obs.	Seconds, 1900. s	N.P.D. ′	″	No. of Obs.	Seconds, 1900. ″
1850	35	37·99	5	30·947	7	21·04	11	57·70 + 1·19
1		40·12	9	·819		27·50	20	0·80
2		42·47	7	·917		34·75	30	1·22
3		44·72	15	·902		41·01	17	0·66
4		46·96	2	·880		...	...	...
5		49·28	7	·942	7	55·00	8	0 81
6		51·50	8	·892	8	2·50	13	1·51
7		53·76	5	·895		9·36	7	1·56
8		56·01	7	·886		16·15	9	1·54
9	35	58·35	6	·968		23·30	5	1·87
1860	36	0·57	5	·929		30·02	5	1·78
1		2·86	5	·971		37·03	10	2·19
2		5·09	3	·942		43·42	4	1·79
3		7·39	3	·984		49·92	3	1·50
4		9·62	5	·954	8	56·72	5	1·52
5		11·91	4	·976	9	3 39	3	1·40
6		14·17	9	·987		9·99	6	1·22
7		16·40	10	·960		16·20	6	0·94
8		18·67	11	·973		22·74	18	0·91
9		20 94	13	·985		29·68	8	1·17
1870		23·16	5	·945		36·42	6	1·04
1		25·43	3	·958		...	...	...

Year.	R.A.	No. of Obs.	Seconds, 1900.	N.P.D.	No. of Obs.	Seconds, 1900.
	m s		s	′ ″		″
1872	36 27·66	3	30·928	9 49·62	6	0·59
3	29·90	7	·913	9 56·62	4	0·92
4	32·22	2	·970	10 3·39	3	0·83
5	34·38	1	·871	...	...	...
6	36·65	6	·877	16·77	6	0·71
7	38·97	9	·940	23·59	7	0·28
8	41·20	7	·905	30·64	5	0·58
9	43·44	4	·893	37·19	9	0·38
1880	45·74	7	·935	44·23	8	0·69
1	47·97	9	·909	51·43	6	1·15
2	...	...	...	10 57·85	6	0·84
3	52·48	5	30·890	11 5·17	7	1·43
4	54·86	3	31·014	11·70	2	1·24
5	57·04	3	30·934	17·98	2	0·75
6	36 59·37	1	31·003	24·71	4	0·81
7	37 1·57	6	30·951	31·42	5	0·80
8	3·79	1	·906	38·08	2	0·74
9	6·06	1	·917	45·72	3	1·66
1890	8·30	7	·898	11 52·32	4	1·55
1	10·59	2	·930	12 0·02	2	2·56
2	12·86	6	·938	5·24	4	1·09
3	15·10	23	·922	12·56	16	1·74
4	17·34	22	·905	18·93	22	1·38
5	19·65	20	·950	25·66	18	1·40
6	21·88	20	·926	...	12	1·66
7	24·16	16	·939	39·19	9	1·52
8	26·44	13	·957	45·53	11	1·18
1899	28·70	31	30·955	52·00	18	0·97

Part III.

Remarks on Colour, Magnitude, Irregular Motion, &c.

The most natural cause of the opening out of the ellipse, its rotation, and the discrepancies in the period would be the duplicity of either star. While the micrometer measures were under discussion there seemed abundant evidence that such was in truth the case with the secondary star, and the idea was somewhat strengthened by its apparent variation in colour and magnitude ; but since the discussion of the meridian observations and an investigation of the colour and magnitude the evidence is all in favour of the primary being double, and this is

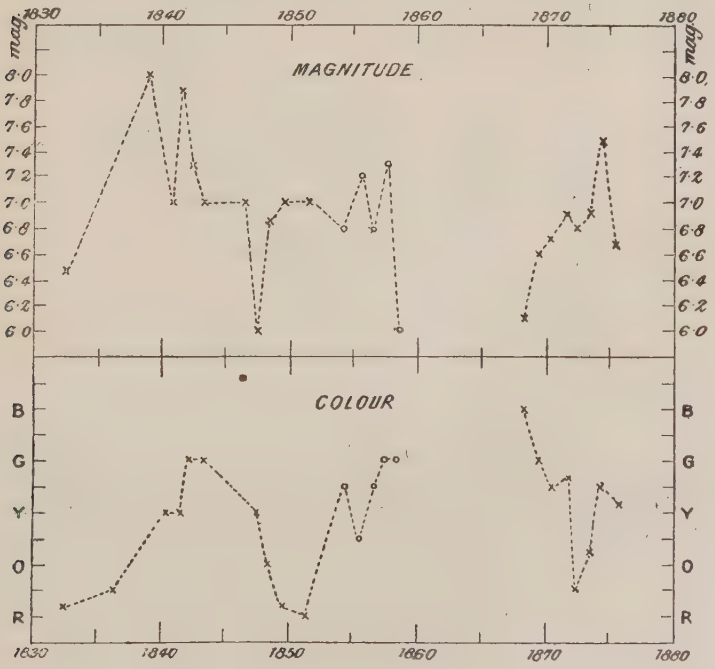
suggested, with some diffidence, as the cause of all the peculiarities of motion in the system.

The grounds upon which this suggestion is based are the wavy lines in figs. 2, 3, 5, and 6 in the first instance, and since the residuals from the meridian observations are more marked than those from the micrometric measures the duplicity is ascribed to the principal star.

The period of this component is about twelve years and the semi-major axis 0″·25.

Magnitude and Colour.

All observers agree in calling the principal star yellow and 3·0 magnitude. The evidence in the case of the small component is not so satisfactory. The personal equation of the observer, the state of the atmosphere, and the colour correction of the object-glass and eyepiece enter so largely into estimations of magnitude, and more especially colour, that the results even of two such careful observers as Dembowski and Dunér are often in conflict. If we confine ourselves to the results of Dawes as a base, and tack those of Struve on one end, and on the other the early estimations of Dembowski, followed by those of Dunér, we obtain what may possibly be a period of seventeen or eighteen years both in colour and magnitude.



To me the colour from 1895 to 1898 was dark blue, whereas it is now a decided green ; and, so far as they go, these observations fall in with those just mentioned. If we accept these results, then the magnitude seems to vary from 6·5 to 7·5 and the colour from red to blue.

1826	Struve	7·0	
32	,,	6·5	
33	,,	...	Reddish
36	,,	...	,,
39	Dawes	8·0	
40	,,	7·0	Yellow
41	,,	7·9	,,
42	,,	7·3	Blue, yellow
43	,,	7·0	,,
46	,,	7·0	
47	,,	6·0	Yellow
48	,,	6·9	Reddish yellow
49	,,	7·0	Pale red
51	,,	7·0	Red
54	Dembowski	6·8	Olive
55	,,	7·2	Orange yellow
56	,,	6·9	Olive
57	,,	7·3	Greenish olive
58	,,	6·0	Yellowish olive
68	Dunér	6·1	Blue
69	,,	6·6	Green
70	,,	6·7	Olive
71	,,	6·9	,,
72	,,	6·8	,,
73	,,	6·9	Orange
74	,,	7·5	Olive
1875	,,	7·0	,,

Spectroscopic Observations.

The spectroscopic determinations of the motion in the line of sight are :—

1893 May	18,	Belopolsky *	−68 km./sec.
,,	22,		−84

* *Ast. Nach.* 133, 257.

1893 June	2,		−75 km./sec.
„	3,		−67
„	4,		−66
„	14,		−64
„	16,		−69
1897 April	29,	Campbell *	−69·1
June	14,	Newall †	−71·4
1898 May	11,	Campbell	−70·4
„	16,	Newall	−68·4
„	23,	Campbell	−70·0
Aug.	19,	Campbell	−70·9
1899 April	29,	Newall	−74·3

If we neglect the determination on 1893 May 22, these reduce to

1893·4	−68·0	km./sec.	= −42·2	miles/sec.
97·9	−69·9	„	= −43·4	„
98·7	−71·6	„	= −44·5	„

From these values the computed parallaxes are 0″·157 and 0″·134, which, seeing that the true anomaly varies 76°, may be regarded with more favour than one is at first disposed to show. Adopting then

0″·14 as the parallax, we obtain :
0·89 as the combined mass,
0·44 as the mass of each star,
925,000,000 miles as the mean distance apart,
2·7 miles the average velocity in orbit,
1·8 the velocity in line of sight at the node,
42·5 miles the observed velocity in line of sight at node,
44·3 „ of approach to our system,
27·9 „ velocity in line of sight due to proper motion,
8·6 „ velocity of proper motion in N.P.D.,
10·0 „ velocity of proper motion in R.A.,
31·0 „ resultant velocity in space.

It is clearly evident that great reliance cannot be placed on the parallax deduced in this way, and the figures above must be regarded as merely giving a general idea of the system. I must say that the consistency of spectroscopic measures has come as a great surprise to me, and no doubt in cases where the change of velocity is large, a fair value of the parallax could be deduced. In the present case a change of even one kilometre in $v-r_1$ has a large effect on the parallax.

* *Astrophysical Journal*, viii. 157.
† Hitherto unpublished.

Magnitude of Wide Companion of ζ Lyræ.

By the Rev. S. J. Johnson, M.A.

In the case of this wide object, almost one suitable for the binocular, the impressions recorded of magnitude seem singularly discordant; and if these estimations have been made with care, they seem to suggest the idea of variability with a long period.

In the *Intellectual Observer*, 1862 December, the Rev. T. Webb says, "In 1850·77 and 1865·68 with $3\frac{7}{10}$ inches, I thought the smaller star 7 and 6. It now appears as in Smyth," that is to say, magnitudes 5, $5\frac{1}{2}$.

In 1876 Plummer gives 4, $6\frac{1}{2}$, an immense difference between the components.

Even in so trustworthy a work as the *Washington Observations of Double Stars, made at the U.S. Naval Observatory*, Part ii., 1880–1891, they are given as "4 and 6."

The following are extracts from my own notes:—

"1884 September 19. Mags. 5, 6, nearly, if not quite, a whole magnitude difference. Colours, yellow, brownish-yellow.

"1887 October 10. Mags. 5, 6. Yellow, lilac-tint.

"1891 January 21. Yellow, bluish. Mags. 5, 6, or more strictly speaking, not above $\frac{3}{4}$ magn. difference.

"1897 May 21. Barely $\frac{1}{2}$ magnitude difference in the stars, the smaller somewhat bluish."

And on November 15 this year, 1900, the same impression: mags. 5, $5\frac{1}{3}$.

The fact that I know of no list of variables in which this star is included seems to make it worth while to remark on the matter.

Melplash Vicarage, Bridport:
December 10.

Observations of the Leonid Meteors of 1900 *made at the Royal Observatory, Greenwich.*

(Communicated by the Astronomer Royal.)

On the night of November 13–14 twenty-five meteors were observed by three observers between midnight and 5^h A.M., five of which were Leonids. The watch was occasionally interrupted by cloud. On the night of November 14–15 the effective watch was limited to two hours only (the sky clouding up completely before 3^h A.M.), and twenty meteors, of which six were Leonids, were seen by two observers. On the night of November 15–16 a watch was maintained by three observers from 11^h P.M. until $3^h\ 30^m$ A.M. (when the sky became overcast), and fifty-five meteors were observed, twenty-three of which were conformable to the *Leo* radiant. There was no appearance of a shower on any of the nights of observation.

Royal Observatory, Greenwich:
1900 December 29.

The Leonids 1900: *Observations at the University Observatory, Oxford.* By H. H. Turner, M.A., F.R.S., Savilian Professor.

Continuous watch was kept on the nights of November 13, 14, 15, with practically no result. On November 13 the sky clouded over at $16^h\ 35^m$; on November 14, at $13^h\ 20^m$; and on November 15 at about $13^h\ 30^m$, though there was a partial clearance about 15^h–16^h. On November 14 about eleven meteors were noticed between the hours of $11^h\ 30^m$ and 14^h, none of them *Leonids*; but no special attention was paid to these observations, the watch being kept simply for a notable display. Several cameras were ready for exposures, but of course no results were obtained.

The Leonids, 1900. *Observations made at the Radcliffe Observatory, Oxford.*

(*Communicated by the Radcliffe Observer.*)

In anticipation of a return of the Leonids this November, arrangements were made for observations, and, in view of the possibility of a dense swarm occurring, an electric cable had been laid from the tower to the chronograph, and a mechanical enumerator was also provided.

On November 11 and 12 an examination of the sky was made at intervals, but the observers failed to detect any Leonids. Much cloud prevailed.

On the night of November 13 Mr. McClellan undertook the watch from 11^h to $14^h\ 30^m$, when he was relieved by Mr. Wickham, who remained on duty till dawn.

On November 14 Mr. Robinson kept watch during the whole period from 11^h till dawn.

It was further arranged that Mr. Jenkins, who slept during these two nights at the Observatory, should, in the event of a shower of meteors, be sent to summon the Radcliffe Observer and the other members of the staff.

The observers on duty report as follows:—

Mr. McClellan.—November 13, $11^h\ 30^m$ to $14^h\ 30^m$ G.M.T. The sky was very variable, being often covered with quickly moving cloud, whilst in the East thin clouds, which remained almost stationary, concealed the radiant until 14^h; after this the "Sickle" could be seen through breaks in drift.

At $13^h\ 30^m$ a sporadic meteor crossed the constellation of *Orion* from E. to W. with a swift motion.

Mr. Wickham.—November 13, $14^h\ 30^m$ to $15^h\ 15^m$. The sky was sufficiently clear to identify all my reference stars, except those below the 4th magnitude, which were invisible, the Moon being near the radiant in the constellation *Leo*. The haze near

the horizon was thick enough to obliterate all stars below the 1st magnitude. At $15^h\ 15^m$ G.M.T. the sky clouded for fifteen minutes, then rapidly cleared, but floating clouds occasionally concealed the Moon and the radiant.

The following notes of meteors were taken :—

G.M.T. h	m	
15	44	Leonid across *Coma Berenices*, $3\frac{1}{2}$ mag. When tracking its course by means of a straight-edged wand, it had evidently proceeded from the *Leo* radiant.
15	52	Two Leonids in rapid succession passed just above δ *Leonis* ; the second was the brighter, and estimated mag. 3.
15	57	Leonid, from near *Mars*, almost perpendicularly into the haze near horizon. *Mars* was in the centre of the triangle formed by α, η, and ψ *Leonis*.
16	8	Leonid, from ζ *Leonis* upwards into *Leo Min.* Reference stars are faint here.
16	8	From *Leo* radiant down to ρ *Leonis*.
16	10	From *Leo* radiant to near ω *Ursæ Majoris*.
16	14·5	Sporadic, from near o *Ursæ Maj.*, past the "Sickle," to just beyond β *Leonis*.
16	21	Leonid, from γ to δ *Leonis*.
16	27·5	Leonid, from γ *Leonis* to ξ *Ursæ Majoris*.
16	29	Leonid, from *Mars* downwards towards horizon.
16	30+	Clouds came up and obscured the whole sky.
18		Shower of rain.

Considering that moonlight, haze, and cloud were serious impediments, and that it is also probable some Leonids escaped notice whilst I was making entries in my note-book of those observed, I am of opinion that in the absence of the Moon from the radiant, and with a clear sky, I should have observed as many as during my watch last year. The meteors noted above preserved their characteristics of yellowish light, rapid motion, and a faint short trail or streak quickly fading out.

Mr. Jenkins.—November $13^d\ 18^h\ 13^m$ to 17^m. "I saw four meteors during breaks in cloud, the only other objects visible being the Moon, *Mars*, and *Regulus*." From a sketch made shortly afterwards, three of these appear to be Leonids, whilst the fourth is doubtful.

Mr. Robinson.—November $14^d\ 11^h$ to $12^h\ 30^m$. Sky covered with detached masses of cloud ; stars only occasionally visible. For the next hour the clouds parted sufficiently to reveal whole constellations, principally *Taurus*, *Gemini*, *Ursæ Maj.*, and *Orion* ; but only stars to mag. 4 were visible. At $12^h\ 50^m$ many faint stars were easily seen. At 13^h, sky thicker, with lunar halo, *Regulus* and *Mars* visible. At 16^h, rain till after dawn.

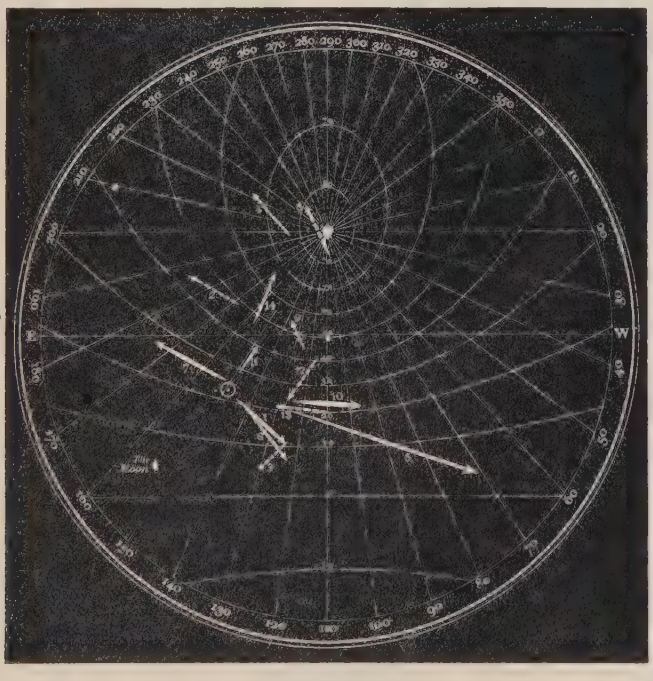
No meteors were seen during the watch ; but, owing to the

unfavourable conditions, meteors fainter than mag. 2 would hardly have been visible, except for a short interval about $12^h\ 50^m$.

On November 15 watches were kept for brief intervals, but no meteors were seen by any of the observers.

The Leonids, 1900 *November* 14: *Observations made at Blackheath, S.E.* By E. M. Antoniadi and A. C. D. Crommelin.

The sky was laden with heavy clouds on the night of November 14–15, but the wide gaps between them were so admirably transparent that stars of the second and third magnitudes in *Canis Major* could be easily seen down to within a very few degrees of the horizon.



Fourteen meteors, of which seven were *Leonids*, were recorded in three hours' watch, from $11^h\ 45^m$ to $14^h\ 45^m$ G.M.T. Owing to the clouds it is impossible to give an horary mean of the number of *Leonids* that would have been visible at the time

with a clear sky. But there is good evidence to show that such mean could scarcely exceed three or four per hour. From $13^h\ 7^m$ to $13^h\ 47^m$ the sky was quite clear, and yet no *Leonid* was seen during this interval of 40^m.

The following table, which is completed by the annexed figure, will speak for itself :—

Meteors seen at Blackheath on 1900 *November* 14 *from* $11^h\ 45^m$ *to* $14^h\ 45^m$.

No.	Hour G.M.T.	Track. From α	Track. From δ	Track. To α	Track. To δ	Mag.	Notes.	Observer.
	h m	°	°	°	°			
1	11 46	145	+21	125	+11	2	Moderately swift. *Leonid.*	C.
2	12 4	168	+48	186	+44	3½	Rather slow.	A.
3	12 15	124	+11	130	+ 6	3	Moderately slow.	C., A.
4	12 19	195	+77	222	+67	5	Swift.	A.
5	12 19½	125	+20	71	+ 4	3	Swift. *Leonid.*	C.
6	12 23	140	+19	123	+ 8	3½	Rather slow. *Leonid.*	C., A.
7	13 2	152	+26	173	+27	2	Rather slow. *Leonid.*	C.
8	13 4	103	+84	244	+81	1	Swift.	A.
9	13 42	124	+44	136	+53	4	Swift; perhaps curved.	A.
10	13 47	124	+23	96	+22	> ♃	Swift; streak. *Leonid.*	A.
11	13 47¼	149	+29	148	+40	5½	Swift. *Leonid.*	A.
12	13 57	117	+41	127	+24	3	Swift.	A.
13	13 59	108	+20	130	+21	3	Swift.	A.
14	14 5	157	+47	169	+65	4	Very swift. *Leonid.*	A.

No 10 was a grand red globe, brighter than *Jupiter*, and leaving an intense emerald green trail, lasting for $1\frac{1}{2}^s$.

By producing backwards the seven *Leonid* tracks we obtain a mean radiant towards

$$\alpha = 149^\circ\ ;\ \delta = +23^\circ.$$

The radiant of Nos. 6 and 7 was distinctly a little higher ; at

$$\alpha = 149^\circ\ ;\ \delta = +25^\circ.$$

This brief account will suffice to show that, in perfect harmony with the investigations of Drs. Downing and Stoney, the recent display of the *Leonids* was an insignificant one, falling far below an ordinary *Perseid* shower.

Watch for the Leonids 1900, *at Markree Observatory.*

By F. W. Henkel, B.A.

Arrangements were made for watches during the nights of November 14, 15, and 16, though in view of the usually unfavourable atmospheric conditions at this time of the year, and the probability of our missing an encounter with a rich part of the stream (alluded to by Mr. Denning in *Nature* for November 8), there arose a feeling of uncertainty as to the result.

On the first night (14–15) rain and unusually high wind continued almost the whole time, so that the sky was completely overcast.

The second night (15–16) was at first somewhat clearer, but rain fell about midnight, and the sky was almost completely hidden by clouds during the remainder of the night. No *Leonids* were seen during the time the watching continued (up to 1 A.M.).

November 16 was a fine day on the whole, and towards midnight the sky became very clear, so that hopes were entertained that something might be seen at last if anything was to be seen at all of the meteors. The sky was watched till about 1 A.M. on the morning of the 17th, when it became overcast in the east, and again at 4 A.M. on the same morning, at which time, however, there were a good many clouds.

Two meteors were seen about 0·30 A.M. (D.M.T.) on the early morning of the 17th, one, fairly bright, with path ending near *ζ Geminorum*, the other, fainter, near *Regulus*. At 4 A.M. no meteors could be seen, though a careful watch was made for some time.

Markree Observatory, Collooney, Ireland :
1900 *November* 18.

Ephemeris for Physical Observations of

Greenwich Noon.	P.	L—O.	B.	Apparent Diameter. Equat. 2a.	Defect.	Polar 2b.	d.	Q.	B′.
1901.	°	°	°	″	″	″	°	°	°
Jan. 17	359·325	134·144	−2·268	32·62	0·06	30·52	4·88	270·71	−2·42
19	359·124	134·573	2·259	32·70	·07	30·59	5·15	270·50	2·41
21	358·925	135·001	2·250	32·79	·07	30·68	5·41	270·30	2·41
23	358·728	135·424	2·241	32·88	·08	30·76	5·67	270·10	2·40
25	358·532	135·844	2·232	32·98	·09	30·85	5·93	269·90	2·39
27	358·338	136·260	−2·223	33·08	·10	30·95	6·18	269·70	−2·38
29	358·147	136·671	2·214	33·19	·10	31·05	6·43	269·51	2·37
31	357·957	137·078	2·205	33·30	·11	31·15	6·67	269·31	2·36
Feb. 2	357·769	137·482	2·196	33·41	·12	31·26	6·91	269·12	2·35
4	357·583	137·880	2·187	33·53	·13	31·37	7·15	268·92	2·34
6	357·400	138·273	−2·178	33·66	·14	31·49	7·38	268·74	−2·33
8	357·219	138·661	2·169	33·79	·15	31·61	7·61	268·55	2·32
10	357·041	139·044	2·160	33·92	·16	31·74	7·83	268·36	2·31
12	356·865	139·423	2·151	34·06	·17	31·87	8·04	268·18	2·30
14	356·692	139·795	2·142	34·21	·18	32·00	8·25	268·01	2·29
16	356·523	140·161	−2·133	34·35	·19	32·14	8·46	267·84	−2·28
18	356·356	140·521	2·124	34·51	·20	32·28	8·66	267·67	2·27
20	356·193	140·874	2·115	34·66	·21	32·43	8·85	267·50	2·26
22	356·033	141·221	2·106	34·83	·22	32·58	9·04	267·33	2·25
24	355·877	141·560	2·097	34·99	·23	32·74	9·22	267·18	2·24
26	355·723	141·893	−2·089	35·16	·24	32·90	9·39	267·02	−2·23
28	355·573	142·220	2·080	35·34	·25	33·07	9·55	266·86	2·22
Mar. 2	355·427	142·540	2·072	35·52	·25	33·23	9·70	266·71	2·21
4	355·283	142·851	2·064	35·71	·26	33·41	9·85	266·56	2·21
6	355·142	143·155	2·056	35·90	·27	33·58	9·99	266·42	2·20
8	355·008	143·451	−2·048	36·09	·28	33·76	10·13	266·28	−2·19
10	354·878	143·738	2·040	36·29	·29	33·95	10·25	266·15	2·18
12	354·751	144·016	2·032	36·49	·30	34·14	10·36	266·02	2·17
14	354·627	144·285	2·024	36·70	·31	34·33	10·46	265·89	2·16
16	354·506	144·545	2·016	36·91	·31	34·53	10·56	265·76	2·15
18	354·393	144·797	−2·008	37·12	·32	34·73	10·65	265·65	−2·15
20	354·283	145·039	2·001	37·34	·33	34·94	10·73	265·54	2·14
22	354·179	145·272	1·994	37·57	·33	35·15	10·80	265·44	2·13
24	354·078	145·494	1·987	37·79	·34	35·36	10·86	265·33	2·12
26	353·980	145·707	−1·980	38·02	0·34	35·58	10·91	265·22	−2·12

Jupiter, 1901. By A. C. D. Crommelin.

Greenwich Noon. 1901.	Longitude of ♃'s Central Meridian. 877°·90 I.	870°·27 II.	Corr. for Phase.	Light-time.	A−O.	B.
	°	°	°	m	°	°
Jan. 17	43·60	31·21	+0·10	50·932	129·262	−2·377
19	359·04	331·39	·12	50·802	129·423	
21	314·49	271·58	·13	50·666	129·585	
23	269·96	211·79	·14	50·522	129·747	
25	225·43	152·00	·15	50·374	129·909	
27	180·92	92·23	+0·17	50·219	130·071	−2·349
29	136·41	32·46	·18	50·058	130·233	
31	91·91	332·70	·19	49·890	130·396	
Feb. 2	47·41	272·94	·21	49·717	130·558	
4	2·92	213·19	·22	49·539	130·720	
6	318·43	153·44	+0·24	49·355	130·882	−2·321
8	273·95	93·70	·25	49·165	131·045	
10	229·49	33·98	·27	48·971	131·207	
12	185·03	334·26	·28	48·770	131·370	
14	140·58	274·55	·30	48·565	131·532	
16	96·15	214·85	+0·31	48·358	131·645	−2·293
18	51·72	155·16	·33	48·141	131·858	
20	7·31	95·49	·34	47·923	132·020	
22	322·90	35·82	·36	47·700	132·183	
24	278·50	336·16	·37	47·472	132·345	
26	234·10	276·49	+0·38	47·241	132·508	−2·263
28	189·72	216·85	·40	47·006	132·671	
Mar. 2	145·35	157·22	·41	46·767	132·834	
4	100·98	97·59	·42	46·525	132·997	
6	56·62	37·97	·44	46·280	133·160	
8	12·28	338·37	+0·45	46·030	133·324	−2·234
10	327·95	278·78	·46	45·778	133·487	
12	283·63	219·20	·47	45·525	133·650	
14	239·32	159·63	·48	45·268	133·813	
16	195·02	100·07	·49	45·009	133·976	
18	150·72	40·50	+0·49	44·749	134·140	−2·204
20	106·43	340°95	·50	44·486	134·303	
22	62·16	281·42	·51	44·233	134·406	
24	17·90	221·90	·51	43·957	134·629	
26	333·65	162·39	+0·52	43·690	134·793	

Greenwich Noon.	P.	L−O.	B.	Apparent Diameter. Equat. 2a.	Defect.	Polar 2b.	d.	Q.	B′.
1901.	°	°	°	″	″	″	°	°	°
Mar. 28	353·889	145·909	−1·973	38·26	0·35	35·79	10·95	265·13	−2·11
30	353·803	146·101	1·967	38·49	·35	36·01	10·98	265·04	2·10
Apr. 1	353·721	146·282	1·960	38·73	·36	36·24	10·99	264·95	2·10
3	353·644	146·452	1·954	38·98	·36	36·47	11·00	264·87	2·09
5	353·572	146·611	1·948	39·23	·36	36·70	10·99	264·79	2·08
7	353·505	146·758	−1·942	39·48	·36	36·93	10·98	264·72	−2·08
9	353·443	146·895	1·936	39·73	·36	37·17	10·95	264·66	2·07
11	353·386	147·020	1·931	39·98	·36	37·41	10·91	264·60	2·06
13	353·335	147·134	1·926	40·24	·36	37·65	10·86	264·54	2·06
15	353·290	147·235	1·921	40·50	·36	37·89	10·80	264·49	2·05
17	353·250	147·324	−1·916	40·76	·36	38·13	10·73	264·45	−2·05
19	353·215	147·401	1·911	41·02	·35	38·37	10·64	264·41	2·04
21	353·186	147·466	1·907	41·28	·35	38·62	10·54	264·38	2·04
23	353·163	147·517	1·903	41·54	·34	38·87	10·43	264·35	2·03
25	353·145	147·557	1·899	41·80	·34	39·11	10·31	264·33	2·03
27	353·132	147·584	−1·895	42·07	·33	39·35	10·17	264·32	−2·03
29	353·127	147·599	1·892	42·33	·32	39·60	10·02	264·31	2·02
May 1	353·126	147·601	1·889	42·59	·31	39·84	9·86	264·31	2·02
3	353·130	147·591	1·886	42·85	·30	40·09	9·68	264·31	2·02
5	353·139	147·568	1·884	43·10	·29	40·33	9·49	264·32	2·01
7	353·154	147·532	−1·881	43·36	·28	40·57	9·29	264·32	−2·01
9	353·175	147·485	1·879	43·61	·27	40·81	9·08	264·34	2·01
11	353·202	147·424	1·877	43·86	·26	41·04	8·86	264·36	2·01
13	353·235	147·352	1·875	44·11	·25	41·27	8·62	264·39	2·00
15	353·273	147·267	1·873	44·35	·24	41·50	8·37	264·42	2·00
17	353·316	147·170	−1·871	44·59	·22	41·72	8·11	264·46	−2·00
19	353·365	147·061	1·870	44·82	·21	41·94	7·84	264·49	2·00
21	353·419	146·940	1·869	45·05	·19	42·15	7·55	264·54	2·00
23	353·478	146·808	1·868	45·27	·18	42·36	7·25	264·59	2·00
25	353·542	146·665	1·867	45·48	·16	42·56	6·94	264·64	1·99
27	353·610	146·512	−1·866	45·69	0·14	42·75	6·63	264·70	−1·99
29	353·684	146·348	1·866	45·89	0·13	42·94	6·30	264·76	1·99
31	353·762	146·175	1·865	46·08	·12	43·12	5·96	264·83	1·99
June 2	353·844	145·993	1·865	46·27	·11	43·29	5·61	264·90	1·99
4	353·931	145·802	1·865	46·44	·10	43·45	5·25	264·98	1·99
6	354·022	145·601	−1·866	46·60	·09	43·60	4·89	265·06	−1·99
8	354·116	145·393	1·866	46·75	·07	43·74	4·52	265·14	1·99
10	354·215	145·176	−1·866	46·89	0·06	43·87	4·13	265·23	−1·99

Greenwich Noon. 1901.	Longitude of Υ's Central Meridian. 877°·90 I.	870°·27 II.	Corr. for Phase.	Light-time.	A − O.	B.
	°	°	°	m	°	°
Mar. 28	289·41	102·89	+ 0·52	43·422	134·956	− 2·173
30	245·18	43·40	·53	43·155	135·120	
Apr. 1	200·96	343 92	·53	42·886	135·283	
3	156·75	284·45	·53	42·618	135 447	
5	112·56	224·99	·53	42·350	135·610	
7	68·38	165·54	+ 0·53	42·083	135·774	− 2·142
9	24·21	106·11	·52	41·816	135·938	
11	340 05	46·69	·52	41·550	136·102	
13	295·90	347 28	·52	41 285	136·266	
15	251·76	287·88	·51	41·022	136 429	
17	207·62	228·48	+ 0·50	40·762	136·593	− 2·110
19	163·50	169·10	·49	40 503	136·757	
21	119 39	109·73	·48	40 246	136·921	
23	75·29	50 37	·47	39·992	137·085	
25	31·20	351·02	·46	39·741	137·249	
27	347·13	291·68	+ 0·45	39·494	137·413	− 2·078
29	303·07	232·36	·44	39·250	137·577	
May 1	259·02	173·05	·42	39·010	137·743	
3	214·97	113·74	·41	38 773	137·907	
5	170·93	54·44	·39	38·539	138·070	
7	126·91	355·15	+ 0·37	38·311	138·234	− 2·045
9	82·89	295·87	·36	38·089	138·398	
11	38·88	236·60	·34	37 873	138·562	
13	354·88	177·34	·32	37·664	138·727	
15	310·89	118·09	·30	37·458	138·891	
17	266·91	58 85	+ 0·29	37·255	139·056	− 2·013
19	222·94	359·62	·27	37·061	139·220	
21	178·98	300·40	·25	36·874	139·384	
23	135 02	241·18	·23	36·694	139·549	
25	91·07	181·97	·21	36·522	139·715	
27	47·12	122·75	+ 0·19	36·357	139·880	− 1·980
29	3·18	63·55	·17	36·197	140·044	
31	319·24	4·35	·16	36·048	140·209	
June 2	275·31	305·16	·14	35·906	140·373	
4	231·38	245·97	·12	35·773	140·537	
6	187·46	186 79	+ ·10	35·649	140·702	− 1·946
8	143·54	127·61	·09	35·532	140·867	
10	99·62	68·43	+ ·07	35·424	141·032	

Greenwich Noon.	P.	L—O.	B.	Apparent Diameter. Equat. 2a.	Defect.	Polar 2b.	d.	Q.	B′.
1901.	°	°	°	″	″	″	°	°	°
June 12	354·316	144·953	−1·866	47·03	0·05	44·00	3·74	265·32	1·99
14	354·421	144·722	1·867	47·15	·04	44·12	3·35	265·42	2·00
16	354·527	144·487	1·867	47·25	·03	44·21	2·95	265·51	−2·00
18	354·637	144·247	1·867	47·35	·02	44·30	2·54	265·58	2·00
20	354·750	144·002	1·868	47·43	·02	44·38	2·13	265·62	2·00
22	354·864	143·752	−1·868	47·50	·01	44·44	1·72	265·63	2·00
24	354·979	143·501	1·869	47·56	·01	44·49	1·31	265·55	2·00
26	355·093	143·247	1·869	47·60	·00	44·53	0·89	265·	−2·00
28	355·209	142·992	1 869	47·63	·00	44·56	0·47	265·	2·00
30	355·327	142·735	1·870	47·64	·00	44·57	0·04	257·	2·00
July 2	355·446	142·478	−1·870	47·65	·00	44 58	0·38	87·	2·00
4	355·564	142·222	1·871	47·65	·00	44·58	0·80	87·	2·00
6	355·680	141·968	1·871	47·62	·00	44·55	1·22	87·	−2·00
8	355·795	141·715	1·871	47·58	·01	44·52	1·64	87·05	2·00
10	355·911	141·464	1·871	47·53	·02	44·47	2·06	87·10	2·00
12	356·025	141·217	−1·871	47·47	·02	44·41	2·47	87·16	2·00
14	356·137	140·974	1·871	47·39	·03	44·34	2·88	87·24	2·00
16	356·247	140·736	1·871	47·30	·04	44·25	3·28	87·32	−2·00
18	356·354	140·504	1·870	47·20	·05	44·16	3·68	87·41	2·00
20	356·460	140·278	1·870	47·09	·06	44·06	4·07	87·50	2·00
22	356·562	140·057	−1·869	46·97	·07	43·94	4·45	87·58	2·00
24	356·660	139·845	1·869	46·84	·08	43·81	4·83	87·67	2·00
26	356·755	139·641	1·868	46·69	·09	43·68	5·20	87·75	−2·00
28	356·845	139·445	1·867	46·53	·11	43·53	5·56	87·83	2·00
30	356·932	139·258	1·865	46·37	·12	43·38	5·91	87·90	1·99
Aug. 1	357·015	139·080	−1·864	46·19	·14	43·21	6·26	87·97	1·99
3	357·093	138·911	1·862	46·01	·15	43·04	6·60	88·04	1·99
5	357·166	138·754	1·861	45·82	·17	42·86	6·92	88·11	−1·99
7	357·234	138·606	1·859	45·62	·18	42·68	7·23	88·19	1·99
9	357·298	138·470	1·857	45·41	·20	42·49	7·54	88·26	1·98
11	357·356	138·344	−1·855	45·20	·21	42·29	7·83	88·32	1·98
13	357·410	138·230	1·853	44·98	·23	42·08	8·10	88·37	1·98
15	357·457	138·128	1·851	44·75	·24	41·87	8·37	88·41	−1·98
17	357·499	138·039	1·848	44·52	·25	41·66	8·63	88·45	1·97
19	357·535	137·960	1·846	44·29	·26	41·44	8·87	88·48	1·97
21	357·565	137·895	−1·843	44·05	·28	41·22	9·11	88·51	1·97
23	357·590	137·841	1·840	43·81	·29	40·99	9·33	88·54	1·97
25	357·609	137·801	−1·837	43·56	0·30	40·76	9·54	88·55	−1·96

Greenwich Noon. 1901.	Longitude of ♃'s Central Meridian. 877°·90 I.	870°·27 II.	Corr. for Phase.	Light-time.	Δ−O.	*B.*
	°	°	°	m	°	°
June 12	55·70	9·25	+0·06	35·324	141·197	
14	11·79	310·08	·05	35·234	141·363	
16	327·88	250·90	·04	35·155	141·528	−1·912
18	283·96	191·72	·03	35·083	141·693	
20	240·04	132·54	·02	35·022	141·858	
22	196·12	73·36	+ 01	34·971	142·023	
24	152·20	14·18	+0·01	34·931	142·189	
26	108·27	315·00	·00	34·898	142·354	−1·877
28	64·34	255·81	00	34·877	142·519	
30	20·41	196·62	·00	34·865	142·685	
July 2	336·47	137·42	·00	34·862	142·850	
4	292·52	78·21	·00	34·870	143·016	
6	248·56	18·99	−0·01	34·886	143·181	−1·841
8	204·59	319·76	·01	34·914	143·347	
10	160·61	260·52	·02	34·950	143·513	
12	116·63	201·28	− ·03	34·996	143·679	
14	72·64	142·03	·04	35·052	143·845	
16	28·65	82·78	0·05	35·117	144·011	−1·806
18	344·65	23·52	·06	35·193	144·177	
20	300·63	324·24	·07	35·278	144·343	
22	256·59	264·94	− ·09	35·371	144·509	
24	212·53	205·62	·10	35·473	144·675	
26	168·46	146·29	0·12	35·584	144·841	−1·770
28	124·38	86·95	·13	35·703	145·007	
30	80·29	27·60	·15	35·830	145·173	
Aug. 1	36·19	328·24	− ·17	35·965	145·340	
3	352·07	268·86	·19	36·108	145·506	
5	307·94	209·47	0·21	36·259	145·673	−1·733
7	263·80	150·07	·23	36·418	145·839	
9	219·64	90·65	·25	36·584	146·006	
11	175·46	31·21	− ·27	36·756	146·172	
13	131·26	331·75	·29	36·935	146·339	
15	87·04	272·28	0·30	37·121	146·505	−1·696
17	42·81	212·79	·32	37·313	146·672	
19	358·56	153·28	·34	37·511	146·839	
21	314·30	93·76	− ·36	37·714	147·006	
23	270·03	34·23	·38	37·923	147·172	
25	225·74	334·69	−0·39	38·137	147·339	−1·659

Greenwich Noon.	P.	L−O.	B.	Apparent Diameter. Equat. 2a.	Defect.	Polar 2b.	d.	Q.	B′.
1901.	°	°	°	″	″	″	°	°	°
Aug. 27	357·622	137·773	−1·834	43·31	0·31	40·52	9·73	88·56	−1·96
29	357·629	137·757	1·830	43·06	·32	40·29	9·91	88·57	1·96
31	357·630	137·755	1·827	42·81	·33	40·05	10·08	88·57	1·95
Sept. 2	357·625	137·764	1·823	42·56	·34	39·82	10·24	88·56	1·95
4	357·615	137·787	1·819	42·30	·35	39·58	10·38	88·56	1·94
6	357·599	137·822	−1·815	42·05	·35	39·35	10·51	88·55	−1·94
8	357·577	137·870	1·811	41·79	·36	39·11	10·63	88·53	1·94
10	357·549	137·931	1·806	41·54	·36	38·87	10·74	88·50	1·93
12	357·514	138·004	1·802	41·29	·37	38·64	10·83	88·46	1·93
14	357·474	138·089	1·797	41·03	·37	38·40	10·91	88·42	1·92
16	357·429	138·187	−1·792	40·78	·37	38·16	10·98	88·39	−1·92
18	357·378	138·297	1·787	40·53	·37	37·92	11·04	88·34	1·91
20	357·321	138·418	1·782	40·28	·38	37·69	11·09	88·28	1·90
22	357·258	138·551	1·777	40·04	·38	37·46	11·13	88·22	1·90
24	357·190	138·697	1·771	39·79	·38	37·23	11·15	88·15	1·89
26	357·117	138·854	−1·765	39·55	·37	37·00	11·16	88·09	−1·89
28	357·039	139·020	1·759	39·31	·37	36·78	11·16	88·01	1·88
30	356·956	139·200	1·753	39·07	·37	36·56	11·15	87·93	1·87
Oct. 2	356·868	139·388	1·747	38·84	·36	36·34	11·12	87·85	1·87
4	356·775	139·589	1·740	38·62	·36	36·13	11·09	87·77	1·86
6	356·677	139·800	−1·733	38·39	·36	35·92	11·05	87·69	−1·85
8	356·574	140·021	1·726	38·17	0·35	35·71	10·99	87·60	1·84
10	356·466	140·252	1·718	37·95	·35	35·50	10·92	87·51	1·84
12	356·353	140·494	1·711	37·73	·34	35·30	10·85	87·41	1·83
14	356·237	140·745	1·704	37·52	·33	35·10	10·77	87·31	1·82
16	356·116	141·006	−1·696	37·31	·32	34·91	10·68	87·21	−1·81
18	355·991	141·276	1·688	37·11	·32	34·72	10·58	87·11	1·80
20	355·862	141·555	1·680	36·91	·31	34·53	10·47	87·00	1·79
22	355·729	141·843	1·672	36·71	·30	34·35	10·35	86·89	1·79
24	355·593	142·139	1·664	36·52	·29	34·17	10·22	86·78	1·78
26	355·453	142·444	−1·655	36·33	·28	34·00	10·08	86·66	−1·77
28	355·307	142·756	1·646	36·15	·27	33·83	9·94	86·54	1·76
30	355·159	143·077	1 637	35·97	·26	33·66	9·79	86·41	1·75
Nov. 1	355·008	143·404	1·628	35·80	·25	33·50	9·53	86·28	1·74
3	354·855	143·740	1·619	35·63	·24	33·34	9·39	86·14	1·73
5	354·698	144·084	−1·609	35·47	·23	33·19	9·24	86·00	−1·72
7	354·537	144 434	1·599	35·31	·22	33·04	9·08	85·86	1·71
9	354·373	144·790	−1·589	35·16	0·21	32·89	8·91	85·71	−1·70

Greenwich Noon. 1901.	Longitude of ♃'s Central Meridian. 877°·90 I.	870°·27 II.	Corr. for Phase.	Light-time.	Δ−0.	*B.*
	°	°	°	m	°	°
Aug. 27	181·44	275·13	−0·41	38·355	147·506	
29	137·12	215·55	·43	38·577	147·673	
31	92·78	155·95	·44	38·804	147·840	
Sept. 2	48·43	96·34	·46	39·035	148·007	
4	4·07	36·72	·47	39·270	148·174	−1·621
6	319·70	337·09	−0·48	39·508	148·341	
8	275·31	277·44	·49	39·748	148·507	
10	230·90	217·77	·50	39·990	148·674	
12	186·47	158·08	·51	40·235	148·840	
14	142·03	98·38	·52	40·483	149·007	−1·583
16	97·58	38·67	−0·53	40·734	149·174	
18	53·12	338·95	·53	40·985	149·340	
20	8·64	279·21	·54	41·237	149·507	
22	324·15	219·46	·54	41·490	149·674	
24	279·65	159·71	·54	41·744	149·841	−1·544
26	235·14	99·94	0·54	41·999	150·008	
28	190·62	40·16	·54	42·255	150·175	
30	146·09	340·37	·54	42·511	150·341	
Oct. 2	101·54	280·56	·54	42·766	150·508	
4	56·98	220·75	·54	43·020	150·675	−1·504
6	12·41	160·92	−0·53	43·273	150·842	
8	327·83	101·08	·53	43·526	151·010	
10	283·25	41·24	·52	43·778	151·178	
12	238·66	341·39	·51	44·028	151·346	
14	194·06	281·53	·50	44·276	151·514	−1·464
16	149·45	221·66	−0·50	44·522	151·682	
18	104·83	161·78	·49	44·766	151·850	
20	60·20	101·89	·48	45·008	152·018	
22	15·57	42·00	·47	45·248	152·186	
24	330·93	342·11	·45	45·485	152·354	−1·424
26	286·29	282·21	−0·44	45·718	152·522	
28	241·64	222·30	·43	45·948	152·691	
30	196·98	162·38	·42	46·175	152·859	
Nov. 1	152·31	102·45	·40	46·399	153·028	
3	107·63	42·52	·38	46 620	153·196	−1·383
5	62·95	342·58	−0·37	46·836	153·365	
7	18·27	282·64	·36	47·048	153·534	
9	333·59	222·70	−0·34	47·255	153·702	

Greenwich Noon.	P.	L—O.	B.	Apparent Diameter. Equat. 2a.	Defect.	Polar 2b.	d.	Q.	B′.
1901.	°	°	°	″	″	′	°	°	°
Nov. 11	354·208	145·154	−1·580	35·01	·20	32·75	8·72	85·57	−1·69
13	354·040	145·525	1·570	34·86	·19	32·61	8·52	85·42	1·68
15	353·869	145·901	1·559	34·72	·18	32·48	8·31	85·27	1·67
17	353·695	146·284	1·548	34·58	·17	32·35	8·10	85·12	1·65
19	353·519	146·671	1·537	34·45	·16	32·23	7·88	84·97	1·64
21	353·341	147·065	−1·526	34·32	·15	32·11	7·65	84·82	−1·63
23	353·162	147·464	1·515	34·20	·14	32·00	7·42	84·67	1·62
25	352·981	147·869	1·503	34·08	·13	31·89	7·19	84·52	1·61
27	352·797	148·278	1·491	33·97	·13	31·78	6·95	84·37	1·59
29	352·611	148·692	1·479	33·86	·12	31·68	6·70	84·22	1·58
Dec. 1	352·424	149·110	−1·467	33·76	·11	31·58	6·45	84·07	−1·57
3	352·237	149·533	1·455	33·66	·10	31·49	6·20	83·93	1·55
5	352·048	149·960	1·442	33·57	·09	31·40	5·94	83·78	1·54
7	351·857	150·391	1·429	33·48	·08	31·32	5·68	83·64	1·52
9	351·666	150·825	1·416	33·39	·08	31·24	5·41	83·49	1·51
11	351·473	151·263	1·403	33·31	·07	31·16	5·14	83·34	1·50
13	351·280	151·705	−1·389	33·23	0·06	31·09	4·87	83·19	−1·48

The following is a list of the Greenwich Mean times when the Zero meridians of the two adopted systems cross the centre of the illuminated disc :—

System I.

G.M.T. 1901.	d	h	m	G.M.T. 1901.	d	h	m	G.M.T. 1901.	d	h	m	G.M.T. 1901.	d	h	m
Jan.	17	8	38·92	Jan.	23	12	18·09	Jan.	29	15	57·11	Feb.	4	19	36·04
		18	29·54			22	8·70		30	1	47·71		5	5	26·63
	18	4	20·16		24	7	59·31			11	38·31			15	17·22
		14	10·77			17	49·91			21	28·91		6	1	7·81
	19	0	1·39		25	3	40·51		31	7	19·51			10	58·40
		9	52·01			13	31·11			17	10·11			20	48·99
		19	42·62			23	21·71	Feb.	1	3	0·71		7	6	39·58
	20	5	33·23		26	9	12·31			12	51·31			16	30·17
		15	23·84			19	2·91			22	41·91		8	2	20·76
	21	1	14·45		27	4	53·51		2	8	32·50			12	11·35
		11	5·06			14	44·11			18	23·09			22	1·94
		20	55·66		28	0	34·71		3	4	13·68		9	7	52·52
	22	6	46·26			10	25·31			14	4·27			17	43·10
		16	36·87			20	15·91			23	54·86		10	3	33·68
	23	2	27·48		29	6	6·51		4	9	45·45			13	24·26

Greenwich Noon.	Longitude of ♃'s Central Meridian. 877°·90 I.	870°·27 II.	Corr. for Phase.	Light-time.	A − O.	B.
1901.	°	°	°	m	°	°
Nov. 11	288·91	162·76	−0·33	47·458	153·871	
13	244·22	102·81	·32	47·657	154·039	−1·343
15	199·52	42·85	·30	47·851	154·208	
17	154·82	342·89	·29	48·040	154·377	
19	110·12	282·93	·27	48·224	154·546	
21	65·42	222·97	−0·26	48·402	154·714	
23	20·72	163·02	·24	48·575	154·883	−1·303
25	336·01	103·05	·23	48·743	155·052	
27	291·30	43·08	·21	48·906	155·222	
29	246·59	343·11	·19	49·063	155·391	
Dec. 1	201·88	283·14	−0·18	49·214	155·559	
3	157·17	223·17	·17	49·359	155·728	−1·262
5	112·46	163·20	·15	49·498	155·898	
7	67·75	103·23	·14	49·631	156·067	
9	23·04	43·26	·13	49·759	156·237	
11	338·33	343·29	·12	49·880	156·406	
13	293·61	283·32	−0·10	49·993	156·575	−1·221

System I.

G.M.T. 1901.	d	h	m	G.M.T. 1901.	d	h	m	G.M.T. 1901.	d	h	m	G.M.T. 1901.	d	h	m
Feb.	10	23	14·84	Feb.	18	8	25·21	Feb.	25	17	35·35	Mar.	5	2	45·32
	11	9	5·42			18	15·78		26	3	25·91			12	35·86
		18	56·01		19	4	6·35			13	16·47			22	26·41
	12	4	46·59			13	56·91			23	7·03		6	8	16·96
		14	37·17			23	47·48		27	8	57·59			18	7·50
	13	0	27·75		20	9	38·04			18	48·13		7	3	58·05
		10	18·33			19	28·61		28	4	38·68			13	48·60
		20	8·91		21	5	19·17			14	29·24			23	39·14
	14	5	59·48			15	9·74	Mar.	1	0	19·80		8	9	29·68
		15	50·05		22	1	0·30			10	10·35			19	20·22
	15	1	40·62			10	50·87			20	0·90		9	5	10·76
		11	31·19			20	41·43		2	5	51·46			15	1·30
		21	21·76		23	6	32·00			15	42·01		10	0	51·84
	16	7	12·33			16	22·56		3	1	32·56			10	42·38
		17	2·91		24	2	13·12			11	23·11			20	32·91
	17	2	53·48			12	3·68			21	13·66		11	6	23·45
		12	44·06			21	54·23		4	7	4·21			16	13·98
		22	34·63		25	7	44·79			16	4·76		12	2	4·51

System I.

G.M.T.				G.M.T.				G.M.T.				G.M.T.			
1901.	d	h	m	1901.	d	h	m	1901.	d	h	m	1901.	d	h	m
Mar.	12	11	55·04	Mar.	28	1	54·94	Apr.	12	15	53·83	Apr.	28	5	51·75
		21	45·58			11	45·45		13	1	44·34			15	42·21
	13	7	36·12			21	35·96			11	34·80		29	1	32·67
		17	26·65		29	7	26·47			21	25·28			11	23·13
	14	3	17·18			17	16·98		14	7	15·76			21	13·59
		13	7·72		30	3	7·48			17	6·24		30	7	4·04
		22	58·25			12	57·99		15	2	56·72			16	54·49
	15	8	48·78			22	48·49			12	47·20	May	1	2	44·95
		18	39·31		31	8	38·99			22	37·68			12	35·40
	16	4	29·84			18	29·49		16	8	28·15			22	25·85
		14	20·37	Apr.	1	4	19·99			18	18·63		2	8	16·30
	17	0	10·90			14	10·49		17	4	9·11			18	6·76
		10	1·43		2	0	0·99			13	59·59		3	3	57·21
		19	51·96			9	51·49			23	50·07			13	47·66
	18	5	42·49			19	41·99		18	9	40·54			23	38·11
		15	33·02		3	5	32·49			19	31·02		4	9	28·57
	19	1	23·55			15	22·99		19	5	21·49			19	19·02
		11	14·07		4	1	13·49			15	11·96		5	5	9·46
		21	4·60			11	3·99		20	1	2·43			14	59·92
	20	6	55·12			20	54·49			10	52·91		6	0	50·36
		16	45·64		5	6	44·99			20	43·39			10	40·81
	21	2	36·16			16	35·49		21	6	33·86			20	31·25
		12	26·68		6	2	25·98			16	24·33		7	6	21·69
		22	17·20			12	16·48		22	2	14·80			16	12·13
	22	8	7·72			22	6·97			12	5·27		8	2	2·58
		17	58·24		7	7	57·46			21	55·74			11	53·02
	23	3	48·76			17	47·95		23	7	46·20			21	43·47
		13	39·28		8	3	38·45			17	36·67		9	7	33·91
		23	29·80			13	28·95		24	3	27·14			17	24·36
	24	9	20·32			23	19·44			13	17·60		10	3	14·80
		19	10·84		9	9	9·93			23	8·07			13	5·24
	25	5	1·36			19	0·43		25	8	58·53			22	55·68
		14	51·88		10	4	50·92			18	48·99		11	8	46·12
	26	0	42·39			14	41·41		26	4	39·45			18	36·56
		10	32·90		11	0	31·90			14	29·91		12	4	27·00
		20	23·41			10	22·39		27	0	20·37			14	17·44
	27	6	13·92			20	12·87			10	10·83		13	0	7·88
		16	4·43		12	6	3·35			20	1·29			9	58·32

System I.

G.M.T. 1901. d h m	G.M.T. 1901. d h m	G.M.T. 1901. d h m	G.M.T. 1901. d h m
May 13 19 48·76	May 29 9 44·92	June 13 23 40·57	June 29 13 36·14
14 5 39·19	19 35·34	14 9 30·98	23 26·55
15 29·62	30 5 25·76	19 21·39	30 9 16·96
15 1 20·05	15 16·17	15 5 11·79	19 7 37
11 10·48	31 1 6·59	15 2·20	July 1 4 57·78
21 0·91	10 57·01	16 0 52·61	14 48·20
16 6 51·34	20 47·42	10 43·02	2 0 38·61
16 41·77	June 1 6 37·84	20 33·43	10 29·02
17 2 32·20	16 28·26	17 6 23·84	20 19·44
12 22·63	2 2 18·67	16 14·25	3 6 9·85
22 13·06	12 9·09	18 2 4·65	16 0·27
18 8 3·49	21 59·50	11 55·06	4 1 50·69
17 53·92	3 7 49·92	21 45·47	11 41·11
19 3 44·35	17 40·33	19 7 35·88	21 31·53
13 34·78	4 3 30·75	17 26·28	5 7 21·95
23 25·21	13 21·16	20 3 16·69	17 12·37
20 9 15·64	23 11·57	13 7·10	6 3 2·79
19 6·07	5 9 1·99	22 57·51	12 53·21
21 4 56·50	18 52·40	21 8 47·91	22 43·64
14 46·92	6 4 42·81	18 38·32	7 8 34·06
22 0 37·36	14 33·22	22 4 28·73	18 24·49
10 27·78	7 0 23·63	14 19·14	8 4 14·91
20 18·20	10 14·04	23 0 9·55	14 5·34
23 6 8·63	20 4·45	9 59·96	23 55·77
15 59·05	8 5 54·86	19 50·37	9 9 46·19
24 1 49·48	15 45·27	24 5 40·79	19 36·62
11 39·90	9 1 35·68	15 31·20	10 5 27·05
21 30·32	11 26·08	25 1 21·61	15 17·48
25 7 20·74	21 16·49	11 12·03	11 1 7·91
17 11·16	10 7 6·90	21 2·44	10 58·33
26 3 1·58	16 57·31	26 6 52·85	20 48·76
12 51·99	11 2 47·72	16 43·26	12 6 39·19
22 42·41	12 38 13	27 2 33·67	16 29·62
27 8 32·83	22 28·54	12 24·08	13 2 20·05
18 23·25	12 8 18·95	22 14·49	12 10·48
28 4 13·67	18 9·35	28 8 4·90	22 0·91
14 4·09	13 3 59·76	17 55·32	14 7 51·34
23 54·50	13 50·17	29 3 45·73	17 41·77

System I.

1901.	G.M.T. d	h	m	1901.	G.M.T. d	h	m	1901.	G.M.T. d	h	m	1901.	G.M.T. d	h	m
July	15	3	32·21	July	30	17	29·47	Aug.	15	7	28·23	Aug.	30	21	28·51
		13	22·65		31	3	19·95			17	18·74		31	7	19·07
		23	13·09			13	10·43		16	3	9·26			17	9·62
	16	9	3·53			23	0·91			12	59·77	Sept.	1	3	0·18
		18	53·97	Aug.	1	8	51·39			22	50·29			12	50·74
	17	4	44·41			18	41·87		17	8	40·81			22	41·29
		14	34·86		2	4	32·35			18	31·32		2	8	31·85
	18	0	25·30			14	22·83		18	4	21·83			18	22·41
		10	15·74		3	0	13·31			14	12 35		3	4	12·97
		20	6·19			10	3·79		19	0	2·86			14	3·53
	19	5	56·64			19	54·28			9	53·38			23	54·10
		15	47·09		4	5	44·76			19	43·90		4	9	44·66
	20	1	37·54			15	35·25		20	5	34·43			19	35·22
		11	27·99		5	1	25·74			15	24·96		5	5	25·79
		21	18·44			11	16·23		21	1	15·50			15	16·35
	21	7	8·89			21	6·72			11	6·04		6	1	6·92
		16	59·34		6	6	57·20			20	56·57			10	57·48
	22	2	49·78			16	47·69		22	6	47·10			20	48·05
		12	40·23		7	2	38·18			16	37·64		7	6	38·62
		22	30·68			12	28·67		23	2	28·18			16	29·19
	23	8	21·13			22	19·16			12	18·72		8	2	19·76
		18	11·60		8	8	9·65			22	9·26			12	10·33
	24	4	2·05			18	0·14		24	7	59·80			22	0·90
		13	52·51		9	3	50·63			17	50·34		9	7	51·47
		23	42·97			13	41·12		25	3	40·88			17	42·03
	25	9	33·43			23	31·63			13	31·42		10	3	32·61
		19	23·89		10	9	22·13			23	21·96			13	23·19
	26	5	14·35			19	12·63		26	9	12·50			23	13·77
		15	4·81		11	5	3·13			19	3·04		11	9	4·35
	27	0	55·28			14	53·64		27	4	53·58			18	54·93
		10	45·74		12	0	44·14			14	44·12		12	4	45·51
		20	36·20			10	34·64		28	0	34·67			14	36·09
	28	6	26·67			20	25·15			10	25·21		13	0	26·68
		16	17·14		13	6	15·66			20	15·75			10	17·26
	29	2	7·60			16	6·18		29	6	·30			20	7·85
		11	58·06		14	1	56·69			15	50·85		14	5	58·44
		21	48·53			11	47·20		30	1	47·40			15	49·03
	30	7	39·00			21	37·72			11	37·95		15	1	39·62

System I.

1901.	G.M.T. d	h	m
Sept.	15	11	30·20
		21	20·78
	16	7	11·37
		17	1·96
	17	2	52·55
		12	43·14
		22	33·73
	18	8	24·32
		18	14·91
	19	4	5·50
		13	56·09
		23	46·69
	20	9	37·28
		19	27·89
	21	5	18·49
		15	9·08
	22	0	59·68
		10	50·28
		20	40·88
	23	6	31·49
		16	22·09
	24	2	12·70
		12	3·30
		21	53·91
	25	7	44·51
		17	35·12
	26	3	25·73
		13	16·34
		23	6·94
	27	8	57·55
		18	48·16
	28	4	38·77
		14	29·38
	29	0	19·99
		10	10·59
		20	1·21
	30	5	51·83
		15	42·45

1901.	G.M.T. d	h	m
Oct.	1	1	33·07
		11	23·69
		21	14·31
	2	7	4·93
		16	55·55
	3	2	46·17
		12	36·79
		22	27·41
	4	8	18·03
		18	8·65
	5	3	59·27
		13	49·90
		23	40·52
	6	9	31 14
		19	21·76
	7	5	12·38
		15	3·01
	8	0	53·63
		10	44·25
		20	34·88
	9	6	25·50
		16	16·13
	10	2	6·76
		11	57·39
		21	48·01
	11	7	38·65
		17	29·28
	12	3	19·90
		13	10·53
		23	1·16
	13	8	51·79
		18	42·43
	14	4	33·07
		14	23·71
	15	0	14·35
		10	4·98
		19	55·61
	16	5	46·25

1901.	G.M.T. d	h	m
Oct.	16	15	36·89
	17	1	27·53
		11	18·16
		21	8·80
	18	6	59·44
		16	50·08
	19	2	40·72
		12	31·36
		22	22·00
	20	8	12·64
		18	3·28
	21	3	53·92
		13	44·55
		23	35·20
	22	9	25·84
		19	16·49
	23	5	7·13
		14	57·78
	24	0	48·43
		10	39·08
		20	29·73
	25	6	20·37
		16	11·02
	26	2	1·67
		11	52·32
		21	42·96
	27	7	33·61
		17	24·26
	28	3	14·91
		13	5·56
		22	56·21
	29	8	46·86
		18	37·51
	30	4	28·16
		14	18·81
	31	0	9·46
		10	0·11
		19	50·77

1901.	G.M.T. d	h	m
Nov.	1	5	41·42
		15	32·07
	2	1	22·72
		11	13·38
		21	4·03
	3	6	54·69
		16	45·35
	4	2	36·01
		12	26·66
		22	17·32
	5	8	7·98
		17	58·63
	6	3	49·28
		13	39·94
		23	30·60
	7	9	21·25
		19	11·91
	8	5	2·57
		14	53·23
	9	0	43·89
		10	34·55
		20	25·21
	10	6	15·87
		16	6·53
	11	1	57·19
		11	47·85
		21	38·51
	12	7	29·17
		17	19·83
	13	3	10·49
		13	1·15
		22	51·81
	14	8	42·47
		18	33·13
	15	4	23·79
		14	14·45
	16	0	5·11
		9	55·77

System I.

1901.	G.M.T. d	h	m	1901.	G.M.T. d	h	m	1901.	G.M.T. d	h	m	1901.	G.M.T. d	h	m
Nov.	16	19	46·43	Nov.	23	19	7·72	Nov.	30	8	38·41	Dec.	6	22	9·07
	17	5	37·10		24	4	58·39			18	29·07		7	7	59·74
		15	27·76			14	49·05	Dec.	1	4	19·74			17	50·41
	18	1	18·43		25	0	39·72			14	10·41		8	3	41·07
		11	9·09			10	30·39		2	0	1·08			13	31·74
		20	59·75			20	21·06			9	51·74			23	22·41
	19	6	50·41		26	6	11·74			19	42·41		9	9	13·08
		16	41·08			16	2·41		3	5	33·07			19	3·74
	20	2	31·75		27	1	53·07			15	23 74		10	4	54·41
		12	22·41			11	43·74		4	1	14·40			14	45·08
		22	13·07			21	34·41			11	5·07		11	0	35·74
	21	8	3·73		28	7	25·08			20	55·73			10	26·41
		17	54·40			17	15·75		5	6	46·40			20	17·09
	22	3	45·06		29	3	6·41			16	37·07		12	6	7 75
		13	35·73			12	57·08		6	2	27·74			15	58·42
		23	26·39			22	47·74			12	18·40		13	1	49·09
	23	9	17·06												

System II.

1901.	G.M.T. d	h	m	1901.	G.M.T. d	h	m	1901.	G.M.T. d	h	m	1901.	G.M.T. d	h	m
Jan.	17	9	3·97	Jan.	24	19	48·18	Feb.	1	6	32·21	Feb.	18	17	16·06
	18	59·77			25	5	43·96			16	27·99		9	3	11·83
	18	4	55·57			15	39·74		2	2	23·76			13	7·59
		14	51·36		26	1	35·52			12	19·53			23	3·35
	19	0	47·15			11	31·30			22	15·30		10	8	59·11
		10	42·95			21	27·08		3	8	11·07			18	54·87
		20	38·74		27	7	22·86			18	6·84		11	4	50·63
	20	6	34·53			17	18·64		4	4	2·60			14	46·39
		16	30·32		28	3	14·42			13	58·37		12	0	42·15
	21	2	26·11			13	10·20			23	54·13			10	37·91
		12	21·90			23	5·98		5	9	49·90			20	33·67
		22	17·68		29	9	1·76			19	45·67		13	6	29·43
	22	8	13·46			18	57·54		6	5	41·44			16	25·19
		18	9·25		30	4	53·32			15	37·21		14	2	20·94
	23	4	5·04			14	49·10		7	1	32·98			12	16·69
		14	0·83		31	0	44·87			11	28 75			22	12·44
		23	56·61			10	40·65			21	24·52		15	8	8·19
	24	9	52·40			20	36·43		8	7	20·29			18	3·94

System II.

1901.	G.M.T. d	h	m
Feb.	16	3	59·69
		13	55·45
		23	51·20
	17	9	46·96
		19	42·71
	18	5	38·47
		15	34·22
	19	1	29·97
		11	25·71
		21	21·46
	20	7	17·20
		17	12·95
	21	3	8·68
		13	4·42
		23	0·16
	22	8	55·91
		18	51·65
	23	4	47·40
		14	43·14
	24	0	38·88
		10	34·62
		20	30·35
	25	6	26·09
		16	21·83
	26	2	17·57
		12	13·31
		22	9·04
	27	8	4·78
		18	0·52
	28	3	56·25
		13	51·98
		23	47·72
Mar.	1	9	43·45
		19	39·18
	2	5	34·91
		15	30·64
	3	1	26·37
		11	22·09

1901.	G.M.T. d	h	m
Mar.	3	21	17·82
	4	7	13·54
		17	9·27
	5	3	4·99
		13	0·72
		22	56·44
	6	8	52·16
		18	47·89
	7	4	43·61
		14	39·33
	8	0	35·05
		10	30·77
		20	26·49
	9	6	22·21
		16	17·93
	10	2	13·65
		12	9·36
		22	5·08
	11	8	0·79
		17	56·50
	12	3	52·21
		13	47·93
		23	43·64
	13	9	39·35
		19	35·06
	14	5	30·77
		15	26·49
	15	1	22·20
		11	17·91
		21	13·62
	16	7	9·33
	17	3	5·04
		12	56·46
		22	52·17
	18	8	47·88
		18	43·59
	19	4	39·30

1901.	G.M.T. d	h	m
Mar.	19	14	35·01
	20	0	30·71
		10	26·41
		20	22·11
	21	6	17·81
		16	13·51
	22	2	9·21
		12	4·91
		22	0·61
	23	7	56·31
		17	52·00
	24	3	47·69
		13	43·37
		23	39·06
	25	9	34·75
		19	30·44
	26	5	26·13
		15	21·82
	27	1	17·51
		11	13·20
		21	8·89
	28	7	4·58
		17	0·26
	29	2	55·95
		12	51·63
		22	47·32
	30	8	43·00
		18	38·69
	31	4	34·37
		14	30·06
Apr.	1	0	25·74
		10	21·43
		20	17·11
	2	6	12·79
		16	8·47
	3	2	4·14
		11	59·82
		21	55·49

1901.	G.M.T. d	h	m
Apr.	4	7	51·17
		17	46·84
	5	3	42·52
		13	38·19
		23	33·87
	6	9	29·54
		19	25·22
	7	5	20·89
		15	16·57
	8	1	12·24
		11	7·92
		21	3·59
	9	6	59·26
		16	54·93
	10	2	50·60
		12	46·28
		22	41·95
	11	8	37·62
		18	33·29
	12	4	28·95
		14	24·60
	13	0	20·25
		10	15·90
		20	11·56
	14	6	7·21
		16	2·87
	15	1	58·52
		11	54·18
		21	49·83
	16	7	45·48
		17	41·13
	17	3	36·79
		13	32·45
		23	28·10
	18	9	23·76
		19	19·41
	19	5	15·07
		15	10·72

System II.

G.M.T. 1901.	d	h	m	G.M.T. 1901.	d	h	m	G.M.T. 1901.	d	h	m	G.M.T. 1901.	d	h	m
Apr.	20	1	6·38	May	5	18	20·55	May	21	11	33·83	June	6	4	46·39
		11	2·03		6	4	16·17			21	29·43			14	41·98
		20	57·69			14	11·79		22	7	25·04		7	0	37·56
	21	6	53·34		7	0	7·41			17	20·64			10	33·15
		16	48·99			10	3·03		23	3	16·24			20	28·73
	22	2	44·64			19	58·65			13	11·83		8	6	24·32
		12	40·29		8	5	54·27			23	7·43			16	19·90
		22	35·92			15	49·89		24	9	3·03		9	2	15·49
	23	8	31·55		9	1	45·51			18	58·62			12	11·07
		18	27·19			11	41·13		25	4	54·22			22	6·66
	24	4	22·82			21	36·74			14	49·81		10	8	2·24
		14	18·46		10	7	32·36		26	0	45·41			17	57·82
	25	0	14·09			17	27·98			10	41·00		11	3	53·41
		10	9·73		11	3	23·60			20	36·60			13	49·00
		20	5·36			13	19·22		27	6	32·20			23	44·58
	26	6	0·99			23	14·84			16	27·80		12	9	40·17
		15	56·62		12	9	10·45		28	2	23·40			19	35·75
	27	1	52·26			19	6·06			12	18·99		13	5	31·34
		11	47·90		13	5	1·67			22	14·59			15	26·92
		21	43·54			14	57·28		29	8	10·18		14	1	22·51
	28	7	39·18		14	0	52·89			18	5·78			11	18·09
		17	34·82			10	48·49		30	4	1·37			21	13·68
	29	3	30·46			20	44·10			13	56·97		15	7	9·26
		13	26·10		15	6	39·71			23	52·56			17	4·85
		23	21·74			16	35·32		31	9	48·16		16	3	0·44
	30	9	17·39		16	2	30·93			19	43·75			12	56·03
		19	13·03			12	26·54	June	1	5	39·35			22	51·61
May	1	5	8·67			22	22·15			15	34·95		17	8	47·20
		15	4·31		17	8	17·76		2	1	30·54			18	42·78
	2	0	59·95			18	13·37			11	26·12		18	4	38·37
		10	55·58		18	4	8·98			21	21·71			14	33·95
		20	51·20			14	4·58		3	7	17·29		19	0	29·53
	3	6	46·82		19	0	0·19			17	12·88			10	25·11
		16	42·44			9	55·80		4	3	8·46			20	20·69
	4	2	38·06			19	51·40			13	4·05		20	6	16·27
		12	33·69		20	5	47·01			22	59·63			16	11·85
		22	29·31			15	42·62		5	8	55·22		21	2	7·45
	5	8	24·93		21	1	38·22			18	50·80			12	3·03

System II.

1901.	G.M.T. d	h	m	1901.	G.M.T. d	h	m	1901.	G.M.T. d	h	m	1901.	G.M.T. d	h	m
June	21	21	58·61	July	7	15	10·99	July	23	8	24·33	Aug.	8	1	39·08
	22	7	54·19			8	1	6·58			18	19·97			11	34·75
		17	49·77				11	2·18		24	4	15·60			21	30·42
	23	3	45·35				20	57·77			14	11·24		9	7	26·08
		13	40·94			9	6	53·37		25	0	6·88			17	21·75
		23	36·52				16	48·96			10	2·51		10	3	17·44
	24	9	32·11			10	2	44·56			19	58·15			13	13·11
		19	27·69				12	40·15		26	5	53·79			23	8·79
	25	5	23·28				22	35·74			15	49·43		11	9	4·47
		15	18·86			11	8	31·35		27	1	45·07			19	0·15
	26	1	14·45				18	26·96			11	40·70		12	4	55·83
		11	10·04			12	4	22·58			21	36·34			14	51·51
		21	5·62				14	18·19		28	7	31·98		13	0	47·19
	27	7	1·21			13	0	13·81			17	27·61			10	42·88
		16	56·79				10	9·42		29	3	23·25			20	38·57
	28	2	52·38				20	5·04			13	18·89		14	6	34·26
		12	47·96			14	6	0·65			23	14·52			16	29·95
		22	43·55				15	56·27		30	9	10·16		15	2	25·65
	29	8	39·13			15	1	51·88			19	5·79			12	21·36
		18	34·72				11	47·50		31	5	1·43			22	17·07
	30	4	30·30				21	43·12			14	57·09		16	8	12·78
		14	25·89			16	7	38·74	Aug.	1	0	52·76			18	8·48
July	1	0	21·47				17	34·36			10	48·42		17	4	4·18
		10	17·06			17	3	29·98			20	44·09			13	59·89
		20	12·66				13	25·60		2	6	39·75			23	55·60
	2	6	8·25				23	21·21			16	35·42		18	9	51·30
		16	3·85			18	9	16·83		3	2	31·09			19	47·00
	3	1	59·44				19	12·45			12	26·75		19	5	42·69
		11	55·04			19	5	8·07			22	22·42			15	38·39
		21	50·63				15	3·68		4	8	18·09		20	1	34·08
	4	7	46·23			20	0	59·30			18	13·75			11	29·78
		17	41·82				10	54·91		5	4	9·42			21	25·47
	5	3	37·42				20	50·53			14	5·09		21	7	21·17
		13	33·01			21	6	46·15		6	0	0·76			17	16·86
		23	28·60				16	41·78			9	56·42		22	3	12·57
	6	9	24·20			22	2	37·42			19	52·08			13	8·28
		19	19·80				12	33·06		7	5	47·75			23	4·00
	7	5	15·39				22	28·69			15	43·42		23	8	59·70

System II.

G.M.T. 1901.	d	h	m
Aug.	23	18	55·41
	24	4	51·11
		14	46·82
	25	0	42·53
		10	38·24
		20	33·95
	26	6	29·67
		16	25·38
	27	2	21·10
		12	16·82
		22	12·55
	28	8	8·27
		18	4·00
	29	3	59·72
		13	55·45
		23	51·17
	30	9	46·90
		19	42·63
	31	5	38·37
		15	34·10
Sept.	1	1	29·84
		11	25·57
		21	21·31
	2	7	17·05
		17	12·79
	3	3	8·53
		13	4·27
		23	0·01
	4	8	55·75
		18	51·49
	5	4	47·25
		14	42·97
	6	0	38·71
		10	34·46
		20	30·20
	7	6	25·95
		16	21·69
	8	2	17·45

G.M.T. 1901.	d	h	m
Sept.	8	12	13·20
		22	8·95
	9	8	4·71
		18	0·49
	10	3	56·24
		13	52·00
		23	47·75
	11	9	43·51
		19	39·26
	12	5	35·03
		15	30·78
	13	1	26·54
		11	22·30
		21	18·06
	14	7	13·82
		17	9·58
	15	3	5·35
		13	1·11
		22	56·88
	16	8	52·66
		18	48·43
	17	4	44·20
		14	39·97
	18	0	35·75
		10	31·52
		20	27·29
	19	6	23·06
		16	18·83
	20	2	14·60
		12	10·37
		22	6·14
	21	8	1·92
		17	57·69
	22	3	53·47
		13	49·25
		23	45·02
	23	9	40·80
		19	36·58

G.M.T. 1901.	d	h	m
Sept.	24	5	32·36
		15	28·14
	25	1	23·92
		11	19·70
		21	15·48
	26	7	11·27
		17	7·05
	27	3	2·84
		12	58·63
		22	54·42
	28	8	50·21
		18	46·00
	29	4	41·80
		14	37·59
	30	0	33·38
		10	29·17
		20	24·96
Oct.	1	6	20·75
		16	16·55
	2	2	12·35
		12	8·15
		22	3·95
	3	7	59·75
		17	55·55
	4	3	51·35
		13	47·15
		23	42·95
	5	9	38·75
		19	34·55
	6	5	30·35
		15	26·15
	7	1	21·95
		11	17·75
		21	13·56
	8	7	9·36
		17	5·16
	9	3	0·96
		12	56·77

G.M.T. 1901.	d	h	m
Oct.	9	22	52·58
	10	8	48·39
		18	44·20
	11	4	40·01
		14	35·83
	12	0	31·64
		10	27·45
		20	23·26
	13	6	19·08
		16	14·89
	14	2	10·70
		12	6·51
		22	2·33
	15	7	58·14
		17	53·95
	16	3	49·76
		13	45·58
		23	41·40
	17	9	37·21
		19	33·03
	18	5	28·85
		15	24·67
	19	1	20·49
		11	16·31
		21	12·13
	20	7	7·94
		17	3·77
	21	2	59·59
		12	55·41
		22	51·23
	22	8	47·05
		18	42·88
	23	4	38·70
		14	34·53
	24	0	30·36
		10	26·19
		20	22·02
	25	6	17·84

System II.

G.M.T. 1901.	d	h	m
Oct.	25	16	13·67
	26	2	9·49
		12	5·32
		22	1·15
	27	7	56·98
		17	52·80
	28	3	48·63
		13	44·46
		23	40·29
	29	9	36·12
		19	31·95
	30	5	27·78
		15	23·61
	31	1	19·43
		11	15·26
		21	11·09
Nov.	1	7	6·93
		17	2·75
	2	2	58·58
		12	54·42
		22	50·25
	3	8	46·09
		18	41·93
	4	4	37·77
		14	33·60
	5	0	29·44
		10	25·28
		20	21·11
	6	6	16·95
		16	12·79

G.M.T. 1901.	d	h	m
Nov.	7	2	8·63
		12	4·47
		22	0·30
	8	7	56·13
		17	51·97
	9	3	47·81
		13	43·65
		23	39·48
	10	9	35·32
		19	31·16
	11	5	27·00
		15	22·84
	12	1	18·68
		11	14·53
		21	10·37
	13	7	6·21
		17	2·05
	14	2	57·89
		12	53·73
		22	49·57
	15	8	45·42
		18	41·26
	16	4	37·10
		14	32·94
	17	0	28·78
		10	24·63
		20	20·47
	18	6	16·31
		16	12·15
	19	2	7·99

G.M.T. 1901.	d	h	m
Nov.	19	12	3·83
		21	59·68
	20	7	55·52
		17	51·36
	21	3	47·21
		13	43·05
		23	38·89
	22	9	34·74
		19	30·58
	23	5	26·42
		15	22·26
	24	1	18·10
		11	13·95
		21	9·79
	25	7	5·63
		17	1·48
	26	2	57·33
		12	53·17
		22	49·02
	27	8	44·87
		18	40·71
	28	4	36·56
		14	32·41
	29	0	28·26
		10	24·11
		20	19·96
	30	6	15·81
		16	11·66
Dec.	1	2	7·51

G.M.T. 1901.	d	h	m
Dec.	1	12	3·36
		21	59·21
	2	7	55·05
		17	50·90
	3	3	46·75
		13	42·60
		23	38·45
	4	9	34·29
		19	30·14
	5	5	25·99
		15	21·84
	6	1	17·69
		11	13·54
		21	9·38
	7	7	5·22
		17	1·09
	8	2	56·93
		12	52·77
		22	48·61
	9	8	44·46
		18	40·31
	10	4	36·16
		14	32 00
	11	0	27·85
		10	23·70
		20	19·55
	12	6	15·39
		16	11·24
	13	2	7·08

The quantities in the ephemeris are to be interpolated directly for the times for which they are required, the equation of light having been already applied.

The position of *Jupiter's* North Pole is assumed to be R.A. $17^h\ 51^m\ 59^s{\cdot}22$, N.P.D. $25°\ 26'\ 24''{\cdot}6$ at the beginning of 1901, and R.A. $17^h\ 51^m\ 59^s{\cdot}49$, N.P.D. $25°\ 26'\ 25''{\cdot}3$ at the beginning of 1902.

P denotes the position-angle of the northern extremity of *Jupiter's* axis, reckoned eastward from the northernmost point of the disc.

L − O + 180°, Λ − O + 180° are the jovicentric right ascensions of the Earth and Sun respectively, reckoned in the plane of the planet's equator from O, the point of the vernal equinox of *Jupiter's* northern hemisphere; B, *B* are the jovicentric declinations of the Earth and Sun above the planet's equator.

I have made a change in the adopted values of the equatorial and polar diameters. Professor T. J. J. See recently made a new series of measures with coloured screens which are published in *Ast. Nach.* 3670. Giving equal weights to his results, those of Professor Barnard, and those obtained with the 28-inch equatorial at Greenwich, the resulting diameters at distance 5·20 are : Equatorial, 38″·373; Polar, 35″·991. I have not, however, adopted these as they stand, but have sought for a quantity which, when added to the equatorial diameter and subtracted from the polar diameter, would give to the oblateness $\frac{a-b}{a}$ the exact value $\frac{1}{15{\cdot}53}$ which was deduced by Professors Cohn and W. S. Adams from the observed motion of the perijove of the fifth satellite, as this method of determining the oblateness is probably more reliable than those depending on direct measures of the disc. The finally adopted values at distance 5·20 are : Equatorial, 38″·419; Polar, 35″·945. The previously adopted values (those of Professor Barnard) are diminished at distance 5·20 by : Equatorial, 0″·103 ; Polar, 0″·167.

The assumed time for light to traverse the unit distance is $498^{s}{\cdot}92$, this being the same value as that used by Mr. Marth.

d denotes the jovicentric angle between the Earth and Sun.

Q denotes the position-angle of the point of greatest phase, and is reckoned eastward from the northernmost point of the disc. It also gives the position-angle of the shadows of the satellites measured from the satellites themselves. I have substituted Q for the angle *w* tabulated in recent years as probably more useful to most observers.

B′ is obtained from B by the formula $\tan B' = \sec \varepsilon_0 \tan B$, where $\sec \varepsilon_0 = \frac{a}{b} = \frac{15{\cdot}53}{14{\cdot}53}$. Since B, B′ can never exceed some 3°, we may take the tangents as proportional to the angles. Hence it suffices in practice to find B′ by the formula $B' = \frac{15{\cdot}53}{14{\cdot}53} B$. This is the same formula as that by which B′ has been found in recent years, but the multiplier has been altered to correspond with the new value of the oblateness. I have discovered, however, that in my previous ephemerides I have inadvertently followed Mr. Marth in an error in stating that B′ computed by the above formula is the jovigraphical latitude of the centre of the disc. It is in reality the eccentric angle of the centre of the disc. If we call B″ the true jovigraphical latitude of the centre of the disc, then we could find B″ by the formulæ :

$$\tan B'' = \sec^2 \varepsilon_0 \tan B \quad \text{or} \quad \tan B'' = \sec \varepsilon_0 \tan B'.$$

Mr. Marth's formulæ on p. 533 of vol. lvi. of the *Monthly Notices* are also wrong. He calls β the jovicentric latitude of a spot and β' the jovigraphical latitude ; but the formulæ that he gives imply that the quantity β' is really the eccentric angle of the spot. If we use his formulæ to find β', then we can deduce the true jovigraphical latitude β'' of the spot by the formula $\tan \beta'' = \sec \epsilon_0 \tan \beta'$.

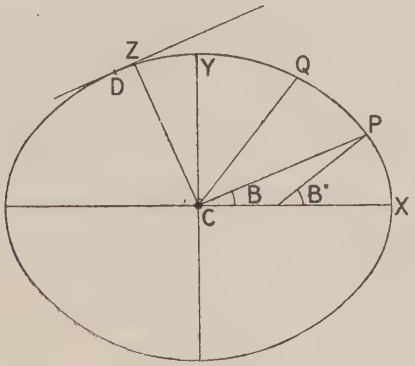


Diagram illustrating the determination of the latitude of Jovian markings and of the centre of the disc.

In order to avoid all possibility of mistake I give the proofs of these formulæ. The ellipse in the figure represents a section of *Jupiter* along that meridian which is central as seen from the Earth. CX, CY are the equatorial and polar radii in this plane, and are taken as the axes of Cartesian coordinates. Then $CX = a$, $CY = b$.

CP is the line joining the centres of the Earth and *Jupiter* ; thus P is the apparent centre of the disc. The oblateness of *Jupiter* and the latitude of the centre of the disc are both exaggerated for the sake of clearness.

Then by definition the angle $PCX = B$.

And if B′ denote the eccentric angle of the point P, then the coordinates of P are $a \cos B'$, $b \sin B'$.

Hence $\tan B = \tan PCX = \dfrac{b \sin B'}{a \cos B'}$.

That is, $\tan B' = \dfrac{a}{b} \tan B = \sec \epsilon_0 \tan B$.

Again, the jovigraphical latitude (B″) of P is the angle which the normal at P makes with CX.

But since the equation to the tangent at P is

$$\frac{x \cos B'}{a} + \frac{y \sin B'}{b} = 1$$

we see that $$\tan B'' = \frac{a}{b} \tan B' = \sec \varepsilon_0 \tan B'$$
$$= \sec^2 \varepsilon_0 \tan B.$$

Again, let CD be conjugate to CP, and let CZ be perpendicular to the tangent at D. Then CZ is the apparent polar semi-diameter.

Let Q be a spot on the central meridian whose measured distance from the centre of the disc is η. (Mr. Marth calls this y, but I prefer to use η, as I have used y for ordinates to the principal axis.)

Let β, β', β'' denote respectively the jovicentric latitude, eccentric angle, and jovigraphical latitude of the point Q.

Then $$\eta = CQ \sin QCP = CQ \sin (\beta - B).$$

Again the coordinates of Q are $CQ \cos \beta$, $CQ \sin \beta$.
But they are also $a \cos \beta'$, $b \sin \beta'$.
Hence $CQ \cos \beta = a \cos \beta'$, $CQ \sin \beta = b \sin \beta'$.
Hence $\eta = b \sin \beta' \cos B - a \cos \beta' \sin B$.
But we have in like manner $CP \cos B = a \cos B'$, $CP \sin B = b \sin B'$.

Hence $$\eta = \frac{a\,b}{CP} \sin (\beta' - B').$$

But by a well-known property of the ellipse $CZ = \frac{ab}{CP}$.

Hence $$\frac{\eta}{CZ} = \sin (\beta' - B').$$

And in an exactly similar manner to the proof for B'' we can show that $\tan \beta'' = \sec \varepsilon_0 \tan \beta'$.

I assume Q to be on the central meridian, as in practice all observations for latitude are or should be made in that position.

In the above investigation a, b, η, CZ are supposed to stand for linear dimensions ; but since in the final formulæ we are only concerned with the ratios $\frac{a}{b}$ or $\frac{\eta}{CZ}$, we may express a, b, η, CZ in these formulæ in seconds of arc without affecting the ratios.

It would be well that any latitude investigations that have been made with the erroneous formula should be revised with the correct one.

The longitudes of *Jupiter's* central meridian are computed with unaltered values of the rates of rotation and of the zero-meridians in the two adopted systems. The addition of the "Corr. for Phase" gives the longitudes of the meridians which bisect the illuminated disc.

The periods of sidereal rotation corresponding to the two adopted systems are $9^h\ 50^m\ 30^s{\cdot}004$, $9^h\ 55^m\ 40^s{\cdot}632$.

According to J. Comas Sola, the longitude of the centre of the bay containing the great red spot was 33° in March 1900, and 39° at the end of June 1900 (*Astr. Nach.* 3671). According to

M. Antoniadi, it was 45° on 1900 October 19. Hence it will probably be about 50° at the commencement of the present ephemeris, and will increase to 60° or more at the end of it.

I.e. in January 1901 the red spot will follow the zero-meridian of System II. by about $1^h\ 23^m$, and this may increase to about $1^h\ 40^m$ in December 1901.

According to J. Comas Sola, the average rotation period of a large number of equatorial spots has been $9^h\ 50^m\ 23^s$ in 1899 and 1900, that is 7^s shorter than the adopted value in System I.

Rev. T. E. R. Phillips has deduced $9^h\ 50^m\ 24^s$ for the period of the south equatorial belt from observations in 1898, 1899, 1900. He gets $9^h\ 55^m\ 41^s{\cdot}66$ as the average rotation period of the great red spot during the same three years.

There will be a transit of the Earth across the Sun as seen from *Jupiter* on 1901 June 30.

As seen from *Jupiter's* centre, the Earth's centre will appear to enter on the Sun June $29^d\ 23^h\ 49^m$ G.M.T., and will appear to leave the Sun June $30^d\ 11^h\ 20^m$ G.M.T. The least distance of centres ($25''{\cdot}5$) will occur at $5^h\ 34^m$ G.M.T. The semi-diameters of the Sun and Earth as seen from *Jupiter* will be $184''{\cdot}2$ and $2''{\cdot}1$.

The only visible effect of the transit will be the fact that Satellite I. during its transit on June 30 will be almost centrally superposed on its own shadow. Owing to the penumbral fringe the shadow appears larger than the satellite, so that it may be seen as a dusky ring round the latter. This will be a most interesting phenomenon for scrutiny with large instruments, and will be observable in Europe and Africa. Ingress occurs at $10^h\ 4^m$ and egress at $12^h\ 21^m$. Prof. Barnard observed a partial occultation of the shadow by the satellite 1893 Nov. 19, though there was no transit in that year (*Monthly Notices*, liv. 3, p. 135).

A few words as to the laws of recurrence of transits of the Earth seen from *Jupiter* may be of interest. I find that a transit occurs when the planet passes through its node within 114 days of opposition. Thus considering the passages of the descending node :—

In 1889 the node was passed 72 days after opposition.
Hence a transit occurred.
In 1901 the node is passed 15 days after opposition. Transit.
In 1913 node passed 41 days before opposition. Transit.
In 1925 node passed 96 days before opposition. Transit.
In 1937 node passed 151 days before opposition. No transit.
In 1949 node passed 207 days before opposition. No transit.
i.e. 192 days after opposition of 1948. No transit.
In 1960 node passed 137 days after opposition. No transit.

Continuing, we find that 1972 corresponds, within a few days, with 1889, and so on. We thus get 4 nodal passages with transits

followed by 3 nodal passages without transits, after which the cycle recurs.

At the other node we find that transits occur in 1894, 1906, 1919, 1931, then occur 3 nodal passages unaccompanied by transits, followed after the 83-year cycle by 4 more passages with transits, and so on. Thus between 1889 and 1931 there are 8 transits, while a transitless interval of $41\frac{1}{2}$ years precedes and follows.*

Another season of eclipses and transits of Satellite IV. is commencing. According to the *Nautical Almanac* the first occultation of the satellite occurs on March 12, the first transit on March 20, the second and third occultations on March 28, April 14, the second and third transits on April 6, 22, the first eclipse on April 30, the first transit of shadow on May 9.

The satellite should be carefully examined on March 28 about $7^h\ 32^m$, and on April 14 about $1^h\ 35^m$, to see whether it enters the shadow of the planet either wholly or partially. The second tabular eclipse on May 17 is visible in Europe, and should be carefully observed. The duration of these early eclipses is very uncertain, and the predicted times of beginning and ending may be greatly in error. It seems unadvisable to give the prediction of these early eclipses to seconds of time, as is done in the *Nautical Almanac*. An error of 30 minutes in the time of disappearance and reappearance is not at all improbable.

Another interesting phenomenon that will take place next year is the conjunction of *Jupiter* and *Saturn*. It is true that the conjunction is not very close, the least distance of centres being 26′ 28″; but with the exception of the triple conjunction in 1683 it is the closest since the invention of the telescope, and affords an opportunity—the only one till 1961—of studying the two giant planets in the same low-power field.

The following little table gives the distance between the planets in longitude and latitude at noon on the days named:—

1901.	Difference of Longitude.		Difference of Latitude. Jupiter South.	Distance of Centres.	Elongation from Sun.
	′		′ ″	′	°
Nov. 21	45	♃ West	26 33	52	45
23	33	,,	26 31	42	43
25	21	,,	26 30	33	41
27	7·6	,,	26 29	27	39
29	5·1	♃ East	26 28	27	37
Dec. 1	18	,,	26 27	32	35
3	31	,,	26 26	41	34
5	44	,,	26 25	51	32

* Many of these relations were given by Mr. Marth in a paper in *Monthly Notices*, xlvi. 3, p. 161.

The planets will be 3° 18′ apart on 1901 May 5. Their distance will then increase to 6° 54′ on August 16, after which they will approach till the conjunction.

I have given fuller details of past and future conjunctions of the planets in the *Journal* of the British Astronomical Association (vii. 3, p. 128).

A list of the times of elongation of the fifth satellite is given in the *Connaissance des Temps* for 1901. The East and West elongations given there for 1899 require to be interchanged. This has been corrected in 1900 and 1901.

It may be mentioned here that the *Connaissance des Temps* for 1899 and following years gives ephemerides for the satellites of *Mars*, *Saturn*, *Uranus* and *Neptune* in the same form as those formerly contributed to the *Monthly Notices* by Mr. Marth.

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